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PHOTOGRAPHIC HANDY-BOOKS.

No. I.

INSTRUCTION
IN
PHOTOGRAPHY.

BY

CAPT. W. DE W. ABNEY, R.E., F.R.S.

LONDON:
PIPER & CARTER, 5, CASTLE STREET,
HOLBORN, E.C.

1884.

[SIXTH EDITION.]

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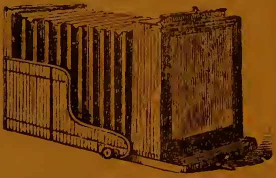

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10 ,, 8	7 0 0	1 0 0	2 0 0	1 5 0	1 1 0	1 8 0	1 12 0	2 0 0
10 ,, 10	7 14 0	1 0 0	2 0 0	1 5 0	1 1 0	1 10 0	1 14 0	2 5 0
12 ,, 10	8 8 0	1 5 0	2 10 0	1 10 0	1 7 0	1 12 0	2 0 0	3 0 0
12 ,, 1	9 3 0	1 5 0	2 10 0	1 10 0	1 7 0	1 14 0	2 2 0	3 10 0
15 ,, 12	10 10 0	1 10 0	3 0 0	2 0 0	1 17 6	2 5 0	2 15 0	5 0 0
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18 ,, 16	17 15 0	1 15 0	3 10 0	2 15 0	2 10 0	3 5 0	4 0 0	6 10 0
18 ,, 18	21 0 0	1 15 0	3 10 0	2 15 0	2 10 0	3 10 0	4 10 0	7 0 0
24 ,, 20	28 0 0	2 5 0	4 10 0	3 12 6	3 0 0	4 15 0	5 15 0	8 0 0
24 ,, 24	32 0 0	2 5 0	4 10 0	3 12 6	3 0 0	5 5 0	6 6 0	8 10 0

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PREFACE TO SIXTH EDITION.

SINCE the last edition of this work was published, the various processes used in photography have not altered in their details to any appreciable extent, nor has any new one to be recorded. The present edition has, however, been brought up to date, and some parts expanded, necessitating an addition of several new chapters.

The advice before given is again repeated, viz., that the older wet process should not be entirely laid aside for the newer gelatine process. Valuable as the latter is, there are some special kinds of photographic work to which it is less suited than the older one. Collodion emulsion, too, is still perhaps the process best adapted for lantern transparencies and out-door dry-plate work when extreme rapidity is not required. Again, too, silver printing still holds its sway over the majority of photographers, yet carbon printing, platinotype, and stannotype should be studied, each possessing an individuality which it would often be advantageous to turn to account.

South Kensington,
October, 1884.

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INSTRUCTION IN PHOTOGRAPHY.

CHAPTER I.

ACTION OF LIGHT ON SILVER COMPOUNDS.

OBSERVATION has shown that nearly every metallic or organic compound undergoes change in the presence of ordinary light. The change may be visible to the eye, as in the case of the darkening of silver bromide by long exposure; or it may be invisible, and only to be ascertained by the behaviour of the compound when certain chemical agents are brought in contact with it, as an example of which we may take the case of a short exposure of silver bromide. The evidence that a change has been produced in the latter is seen in the application of one or other of what are termed developers. This latter change, however, is as real as the former, and any difference between them is, as a rule, solely in the *number* of molecules, composing the compound, which are altered.

It will be evident that when an image is formed by a lens on a surface containing such a compound, the different parts of it will correspond to the different gradations of light acting on them; or that if the light be controlled by a screen allowing different intensities to pass, the same result will be obtained. The developable image was usually called the "latent," or, what is far preferable, the "photographic" image. These terms are more particularly applied to the invisible change which takes place in a film containing or formed by a compound of silver; and such compounds as are capable of being impressed by an image are termed "sensitive."

The sensitive salts of silver which are usually employed in photography are—the iodide, the bromide, and the chloride of silver; and they are the compounds which at present possess most advantages. There are others, which are rarely used, and to which we may refer further on.

In order to illustrate the theory of the formation of a photographic image, the iodide will be taken as a type, the action of light on the other salts being similar. Silver iodide (AgI) can be formed in two or more ways—by the action of a soluble iodide on a soluble salt of silver, or of iodine vapour upon metallic silver. The first method is that employed for its formation in ordinary photography:—The soluble iodide of a metal, such as cadmium; or alkali, such as ammonium, &c., is brought in contact with a solution of silver nitrate; the iodine, having a strong affinity for the silver, forms silver iodide, setting free the nitric anhydride, which in its turn combines with the metal originally in combination with the iodine. Chemically, it is expressed thus—

Cadmium Iodide and Silver Nitrate form Silver Iodide and Cadmium Nitrate

$$(1) \quad CdI_2 + 2AgNO_3 = 2AgI + Cd(NO_3)_2$$

In the above equation, if we were to substitute bromine (Br) or chlorine (Cl) for iodine (I), the same would hold good, the decomposition being similar.

The chemical change that takes place in the iodide of silver by the light, whether visible when long, or invisible when short exposure is given to it, we have very good reason to believe to be the formation of a silver sub-iodide. Thus—

Silver Iodide gives Silver Sub-iodide and Iodine

$$(2) \quad 2AgI = Ag_2I + I$$

We may substitute the chloride or the bromide of silver in the equation for the iodide, and we shall have sub-chloride or sub-bromide formed, with the liberation of chlorine or bromine respectively.

The above equation shows what may be supposed to occur to the three silver salts; but one important factor has been omitted. It is absolutely necessary that some halogen absorbent be present, in order to allow the above reaction to take place. If, for example, a film be prepared of pure iodide of silver, as in the wet collodion process, and after immersion in the silver bath be washed and treated with iodide of potassium or iodine in water, and again washed to free it from all excess of soluble iodide or iodine, such a change as that indicated above will take place with extreme difficulty; but if such a plate be treated with an organic substance such as beer, or an inorganic substance such as potassium nitrite, the silver iodide is able to part with its atom of iodine as indicated. In the same way, if silver nitrate be present, it acts as an iodine absorbent. In the case of the organic matter, we have a combination formed with the iodine. One atom of iodine eliminates one of hydrogen or an hydroxyl (HO) group from the compound, and takes its place, and another combines with the hydrogen or hydroxyl liberated to form hydriodic acid (HI), or this with nascent oxygen. With potassium nitrite we have—

Iodine, Potassium Nitrite, and Water[*] form Hydriodic Acid and Potassium Nitrate

(3) $2I + KNO_2 + H_2O = 2HI + KNO_3$

When silver nitrate is the absorbent, as in the wet collodion process, the reaction is somewhat different. It is usually considered to be as follows:—Multiplying equation (2) by 6, we have six atoms of iodine (6I) coming in contact with six atoms of silver nitrate ($6AgNO_3$).

Iodine, Silver Nitrate, and Water produce Silver Iodide, Silver Iodate, and Nitric Acid

[†] $6I + 6AgNO_3 + 3H_2O = 5AgI + AgIO_3 + 6HNO_3$

It must not be supposed that this chemical change necessarily takes place in the whole of the silver iodide present; far from it—the change takes place in an infinitely small proportion of it, perhaps only on the surface of the minute granules exposed to light.

To Dr. Vogel[‡] must be given the credit of laying down the above law regarding the necessity of absorbents of the halogens (I, Br, and Cl), and he has rightly named such bodies *sensitizers*. With silver iodide, under ordinary atmospheric conditions, as we said, such an absorbent is absolutely necessary; but with silver chloride or bromide the chlorine or bromine will be evolved with-

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[*] Plates prepared with potassium nitrite always contain a certain amount of moisture, owing to the hygroscopic nature of the salt.

[†] When bromine and chlorine are liberated from silver bromide and chloride respectively in the presence of silver nitrate, the reaction that takes place may be somewhat different, but not essentially so. In the above equation it is possible that oxygen is liberated, and no iodate formed.

[‡] *Photographic News*, 1865, page 209.

out it, probably on account of the moisture which is always ready to combine with them on liberation.

We now come to a part of our subject which the beginner may not at first understand and appreciate, though it is in reality most important in its bearings on photographic processes.

When a thin slice of light is decomposed by a prism, it is separated into all the rainbow colours, which, though passing imperceptibly from one into the other, yet, for the sake of perspicuity, have been divided into seven primary colours. These are red, orange, yellow, green, blue, indigo, and violet. Experiment has shown that the rays which are included between the green and the violet cause a change in the silver compounds which are mostly employed by photographers. Those rays of light which will effect a change (visible or invisible) are often termed "actinic" or "chemical rays"; all others, non-actinic. These terms are, however, misleading, except when properly guarded by mental reservations. It entirely depends on the sensitive compound employed as to which rays are "actinic." It will be seen, for instance, that to one modification of silver bromide* all the rays of the spectrum are "actinic," and none "non-actinic."

Prismatic Spectrum.

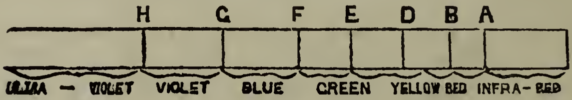

Fig. 1.

It must also be noted below that when a ray of white light is decomposed by a prism into its primary colours, a change in a compound is always produced beyond the place where the extreme violet ray is seen. These rays, together with others below the red, are called dark rays of the spectrum, and are usually denoted as ultra-violet and infra-red respectively. The former will in the case of every ordinary silver salt produce a change, so that they are "chemically effective" rays.

In order to determine as to what rays any particular compound is sensitive, appeal must be made to the spectroscope as applied to photographic purposes. This has been done by several workers,

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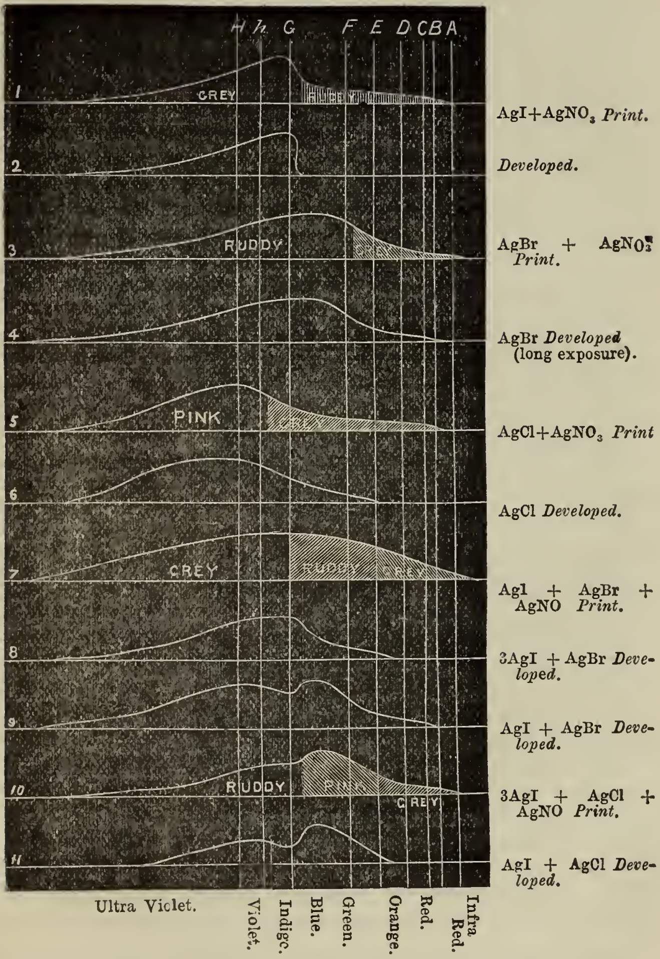
* *Phil. Trans.*, 1881, Bakerian Lecture; also *Photographic Journal*, 1881, page 95.

Fig. 2.


H h G F E D C B A
1 GREY
2
3 RUDDY GREY
4
5 PINK GREY
6
7 GREY RUDDY GREY
8
9
10 RUDDY PINK GREY
11
AgI+AgNO$_3$ Print.
Developed.
AgBr + AgNO$_3$ Print.
AgBr Developed (long exposure).
AgCl+AgNO$_3$ Print
AgCl Developed.
AgI + AgBr + AgNO Print.
3AgI + AgBr Developed.
AgI + AgBr Developed.
3AgI + AgCl + AgNO Print.
AgI + AgCl Developed.
Ultra Violet.
Violet.
Indigo.
Blue.
Green.
Orange.
Red.
Infra Red.

but as we have traversed the ground recently,* we think that the determinations then traced will be found at all events as accurate as any which might be quoted. In the accompanying diagram, the amount of sensitiveness to each ray is shown by the height of the curve above the base line. It will be noticed that the effect of the direct action of light as shown by printing is given in figs. 1, 3, 5, 7, and 10. In these cases the sensitive salt was formed in ordinary paper by salting the *paper*, as will be described in a subsequent chapter, and then floating it on a solution of silver nitrate, and drying. We may here state, that if a collodion film had been used instead of paper, the effects would have been precisely the same as shown in figs 2, 4, 6, 9, and 11.

Fig. 2 shows the chemical effect of the spectrum on pure silver iodide, developed by any method.

Fig. 4 shows the spectrum impressed on silver bromide, developed by any method.

Fig. 6 shows the spectrum impressed on silver chloride, developed by any method.

Fig. 8 shows a silver bromo-iodide wet plate.

Fig. 9 shows a silver bromo-iodide dry plate, developed by any method.

Fig. 11 shows a dry silver chloro-iodide dry plate, developed by any method.

Fig. 1 shows a print on silver iodide paper in the presence of free silver nitrate.

Fig. 3 shows a print on silver bromide paper in the presence of free silver nitrate.

Fig. 5 shows a print on silver chloride paper in the presence of free silver nitrate.

Fig. 7 shows a print on silver bromo-iodide paper in the presence of free silver nitrate.

Fig. 10 shows a print on silver chloro-iodide paper in the presence of free silver nitrate.

The reader should note the limited range of the silver iodide, and even more so of the silver chloride. There is also a remarkable fact in connection with silver bromo-iodide and silver chloro-iodide. When exposed wet, these salts combine the sensitiveness of the two salts; but when exposed dry, the bromine or chlorine

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* Proc. Royal Society, vol. xxxii.; *Photographic Journal*, May, 1882.

liberated by the action of light destroys the sensitiveness in that region of the spectrum (near G) in which the effect on the iodide is most marked. This is caused by the bromine or chlorine attacking the sub-iodide. Thus—

Silver Sub-iodide	and	Chlorine or Bromine	gives	Silver Iodo-chloride or Bromide
Ag_2I	+	Cl or Br	=	Ag_2ICl or Ag2IBr.

This has an important bearing on the dry plate process, in which such mixtures are to be found. This will be referred to in another chapter.

We have recently shown* that the action of light on sensitive salt of silver is increased by heating the silver compound during exposure. The effect of the heat is to cause the halogen to be more readily liberated than when the haloid salts of silver are cool. This fact, no doubt, will be called into practical account before long.

It must be remembered that white light only effects a chemical change in a compound because, of its constituent rays, some are effective; and it is because the red and orange glasses, as a rule, cut off all rays chemically active (actinic) on the silver compounds ordinarily employed, that coloured glass of these hues is used in our developing rooms, the light admitted through such glass being incapable of producing any primary change on them.

There are certain organic, silver, and iron compounds† which are acted upon by the yellow and red rays, and even by the dark rays in the spectrum below them, and when employing the silver salt it is necessary to be careful as to the light admitted whilst developing an image impressed on them.

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* *Photographic News*, May, 1884.

† For an account of these see Hunt's "Researches on Light," and "The Chemical Effect of the Spectrum," by Dr. Eder, translated by the author.

CHAPTER II.

THEORY OF DEVELOPMENT.

As already pointed out, the reduction of the iodide or bromide to the state of sub-iodide or sub-bromide may be invisible or latent. What is technically called a "developer" is that agent which brings the chemical change to the cognizance of our senses. Development may be of such a kind as merely to alter the colour of the light-affected particles, and not to build up an image upon some few that may have been altered. In the first case it is evident that the action of light must be, however, very much prolonged to obtain any appreciable result; whereas in the second, the impact of light may have been of very limited duration. The first we may dismiss from our minds when dealing with silver salts and camera images, and we need only concern ourselves with the second. We may divide developers into two classes, one in which the image is built up from the matter external to the film, and the other in which it is built up from matter in the film itself. We will deal with the first class to commence with.

Acid Development.—Pyrogallic acid is a body which is well known for its affinity for oxygen, as are the ferrous salts, these latter being changed to the ferric state—that is, they combine with more oxygen. When the oxidation of these bodies takes place in the presence of silver nitrate, silver is deposited. We will take the example of the iron salts when applied to the latent image to see how development is effected. The theory is based on the assumption that silver sub-salt, such as the sub-iodide Ag_2I, has an attraction for freshly-precipitated metallic silver, which is consequently deposited upon those parts acted upon by light. If to a solution of silver nitrate be added a solution of ferrous sulphate, the reaction that takes place is this:—

$$\overset{\text{Silver Nitrate}}{3AgNO_3} \overset{\text{and}}{+} \overset{\text{Ferrous-sulphate}}{3FeSO_4} \overset{\text{give}}{=} \overset{\text{Silver}}{3Ag} + \overset{\text{Ferric sulphate,}}{Fe_2(SO_4)_3} \overset{\text{and}}{+} \overset{\text{Ferric-nitrate}}{Fe(NO_3)_3}$$

In the formulæ for developers (Chapter VII.) it will be noticed, however, that the addition of (acetic) acid is invariably included. If to a solution of pure ferrous sulphate (or pyrogallic acid) a solution of silver nitrate be added, there will be an almost instantaneous deposit of metallic silver. If, therefore, the former solution were flowed over an exposed plate which had free nitrate of silver on it, an immediate precipitation of silver would take place all over the film. The attraction of the sub-iodide of silver would be rendered void, owing to the rapidity of deposition. With an acidified solution, however, the deposition would take place with greater regularity and less rapidity, and when sufficiently slow the sub-iodide would be able to attract all the particles of metallic silver as they were formed, and thus build up a metallic image. In practice the acid added is just sufficient to regulate this reduction of the silver. Not only is acetic acid effective, but nitric acid, sulphuric acid, citric acid, and, in fact, most of the organic acids. Acetic acid is selected on account of its mild restraining power, and a consequent finer deposit. Since heat increases the rapidity of chemical action, it follows that a larger quantity of acetic acid must be used in decidedy hot than in cold weather.

Not only do acids restrain the reduction of the silver nitrate, but viscous matter is also capable of giving a physical restraint to the rapidity of the chemical change. Thus, if pyrogallic acid be dissolved in water to which twice the bulk of glycerine is added, the reduction will take place very slowly, or at least sufficiently slowly to allow an image to be be developed.

A little consideration will show that when this action takes place, the image must be principally *on the surface of the film*, and not in it. Experience shows that such is the case.

It will also be noticed in the different formulæ for developing solutions (Chap. VII.) that different quantities of the ferrous salt are given. The stronger the iron solution, the greater chemical power it will have, and the more rapidly it will decompose the silver solution. Consequently, with a strong solution, all parts of the picture acted upon by light will immediately become nuclei for the deposition of silver, and the deposit will be of more even density than if a weaker solution had been employed; for with the latter those parts most acted upon by the light—*i.e.*, which had been most thoroughly converted into sub-iodide—having the most attractive force, would draw the deposit of silver to them, and the image would be much more intense at those parts than where the light had less strongly acted.

*Alkaline Development.**—With dry plates, and sometimes with wet plates which have been thoroughly washed from all silver nitrate,† there is another system pursued of calling forth the invisible image, known as "alkaline development." The silver compound to which it is usually applied is the bromide, though both the chloride and iodide can be rendered amenable to it by taking certain precautions which need not be enumerated here. Taking, as an example, silver bromide as the salt on which the image is to be developed, and pyrogallic acid rendered slightly alkaline by ammonia as the developer, we will trace what happens. When silver bromide is exposed to light, we have the formation of a certain small quantity of silver sub-bromide. If plain pyrogallic acid be applied to this, it will be found that scarcely any developing action is shown, even after prolonged contact; but that if a drop of weak ammonia be added, a blackening of the exposed parts at once takes place, and analysis shows that metallic silver is formed.

Now, the silver sub-bromide is itself a dark-coloured body, and if the exposure be so short as to produce no visible discolouration, yet blackening by the developer will take place, which indicates that not only those particles which are acted upon by light get reduced, but that those adjacent to it are in some way affected. Experiment‡ has shown that silver bromide does not exist in molecular contact with freshly deposited metallic silver, hence the moment the silver sub-bromide is attacked and reduced

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* Major Russell first brought into proper working conditions the method of alkaline development in 1862. It seems, however, to have been first used in America. See *Photographic Journal*, 1865.

† Silver nitrate is at once reduced to the metallic state by alkaline development. Both alkaline and organic iron development are only suitable where the silver salt is a solid, and not in solution.

‡ For a fuller account of this, see the *Photographic Journal*, 1877.

to the metallic state, at once fresh silver sub-bromide is mechanically formed by the combination between the metallic silver and the silver bromide, thus:—

Silver	and	Silver Bromide	form	Silver Sub-bromide
Ag	+	AgBr	=	Ag_2Br

This new sub-bromide, in its turn, is ready for reduction by the developer. Now experiment also proves that silver sub-bromide is more readily attacked by the alkaline solution than the ordinary bromide; hence we can trace the reason of the possibility of a developed image. Again, in the formulæ with pyrogallic acid it will be noticed that a soluble bromide is recommended to be added to the solution of pyrogallic acid and ammonia. This is to check the reduction of the unaltered silver bromide, the soluble bromide seemingly forming a compound with it, which is practically unattackable by the developer.

The action of the alkaline pyrogallic solution is as follows, the developer having been analysed* as to its constituents:—The silver bromide is split up into silver and bromine, which is at once absorbed by the ammonia to form ammonium bromide, and probably a more complex compound, and the oxygen of the ammonia combines with the pyrogallic acid, some intermediate actions taking place. From analysis it is shown that a weak solution of alkaline developer reduces less silver sub-bromide than a stronger one, and practically this is also found to be the case, since an image developed by strong solutions is always more intense than that developed by a comparatively weak one.

Development by Organic Ferrous Salts.—Another class of developers which act similarly to the alkaline developers are the organic ferrous salts,† such as the ferrous oxalate, and we can trace in them more readily the action that takes place.

Ferrous Oxalate	and	Silver Sub-bromide	give	
$3(Fe,C_2O_4)$	+	$2Ag_2Br$	=	
Ferric Oxalate	and	Ferrous Bromide	and	Silver
$Fe_2,(C_2O_4)_3$	+	$FeBr_2$	+	4Ag

By which it will be seen that a metallic bromide is formed, together with ferric oxalate.

It will be shown in another chapter that ferric oxalate destroys

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* *Photographic Journal*, 1877, and *Philosophical Magazine*, Jan. 1877.

† Mr. Carey Lea, and Mr. W. Willis, Jun., introduced this method of development almost simultaneously. See *British Journal of Photography*, 1877, page 293.

the developable image, hence it is a retarder. Ferrous bromide is also a greater retarder of development than the potassium bromide. The writer has shown that the addition of a small quantity of hyposulphite aids development with the ferrous oxalate, and that a plate requires less exposure when using it. Let us trace what happens first as regards the ferrous bromide formed :—

Sodium Hyposulphite	and	Ferrous Bromide	give
$Na_2S_2O_3$	$+$	$FeBr_2$	$=$
Hyposulphite of Iron	and	Sodium Bromide	
Fe,S_2O_4	$+$	$2NaBr_3$	

Whence it will be seen that the extra retarding influence of the ferrous bromide vanishes, and the milder retarding sodium bromide is formed. Again, if we trace what will happen when sodium hyposulphite is added to ferric oxalate, we shall find that ferrous hyposulphite and oxalate are formed, and also a sodium oxalate. Dr. Vogel believes that the good effect of the hyposulphite is due to the hyposulphite of iron formed. We ourselves, at the present moment, are not inclined to hold to this explanation. It seems almost more likely that the destruction of ferric salt immediately on its formation is one cause of the acceleration of development.

The reader may have gathered that with alkaline development or with the ferrous oxalate development there is a tendency for the image to spread laterally as well as down through the film, and microscopic measurement has amply proved this. The lateral spread is not sufficient, however, to be any drawback, except in the case of photo-micrographs. An interesting experiment[†] to make is to expose a dry plate in the camera, and coat half of it with a film of collodion emulsion; and then to develop by the alkaline or ferrous oxalate method. It will be found that the image is fed, as it were, from the top film; and that if two films be separated, the image will be on both. This is an experiment which explains more of the theory of alkaline and organic iron developments than any other with which the writer is acquainted.

[†] See *Photographic Journal*, 1881, page 22.

CHAPTER III.

THEORY OF INTENSIFICATION AND FIXING.

Intensification.—Any method of increasing the opacity of the developed image to the chemically active rays, either by changing its colour or rendering the deposit thicker, is technically called "intensifying a negative,"* and the agents used are called "intensifiers."

Either pyrogallic acid or ferrous sulphate may be employed with a solution of silver nitrate to increase the density by thickening the deposit of the metallic silver. The reactions here are analogous to those of development, except that the metallic silver is the attractive matter instead of the sub-iodide. As the silver is gradually reduced to the metallic state, it is deposited on the silver already reduced by the action of the developer.

There are other methods of increasing the deposit, such as treating the deposited silver with mercuric-chloride, to form a double salt of mercury and silver, and a change may take place in the colour as well as in the density of the deposit. Change in colour may be produced by substitution; as an example, if we treat the developed image with gold tri-chloride, we shall have the following reaction:—

$$\underset{\text{Silver}}{3Ag} \text{ and } + \underset{\text{Auric Chloride}}{AuCl_3} \underset{\text{give}}{=} \underset{\text{deposited Gold}}{Au} \underset{\text{and}}{+} \underset{\text{Silver Chloride}}{3AgCl}$$

In other words, the gold displaces the silver. The equation,

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* Manifestly, adding to the thickness of the deposit of a positive picture is useless. The colour may, however, be changed, in which case the action is termed "toning," and not "intensifying."

however, indicates that the image would be weakened in density, as one atom of gold takes the place of three of silver.

In the formula for intensification, there are several given in which different metallic salts are used to produce the change. We will now (theoretically) explain one or two of these. It will be seen, for instance, that potassium bromide and cupric sulphate[*] are applied to the silver image, which is then treated with silver nitrate. The reaction is as follows :—

Cupric Sulphate and Potassium Bromide form Cupric Bromide and Potassium Sulphate

$$CuSO_4 + 2KBr = CuBr_2 + K_2SO_4$$

In other words, this is a means of producing cupric bromide.

When cupric bromide is applied to metallic silver, we have—

Cupric Bromide and Metallic Silver form Cupric Bromide and Silver Bromide

$$CuBr_2 + Ag = CuBr + AgBr$$

When silver nitrate is applied to the cuprous bromide, we have—

Cuprous Bromide and Silver Nitrate form Cupric Nitrate and Silver Sub-Bromide

$$CuBr + 2AgNO_3 = Cu(NO_3)_2 + Ag_2Br$$

Thus, on one atom of silver, another atom of silver bromide and one of sub-bromide are deposited. Again, Eder and Toth's ferrocyanide of lead intensifier is explained in this way[†] :—

Potassium Ferricyanide, Silver, and Lead Nitrate form

$$2K_6Fe_2Cy_{12} + 4Ag + 6Pb_2No_3)_2 =$$

Ferrocyanide of Silver and Lead Ferrocyanide and Potassium Nitrate

$$Ag_4FeCy_6 + 3Pb_2FeCy_6 + 12KNO_3$$

Again, when mercuric chloride is applied to metallic silver, we have the following formed :—

Mercuric Chloride and Silver form Calomel and Silver Chloride

$$2HgCl_2 + 2Ag = Hg_2Cl_2 + 2AgCl$$

If this is followed by the application of strong ammonia, we have the following formed :—

Calomel and Ammonia form Di-mercurous Ammonium Chloride and Ammonium Chloride

$$Hg_2Cl_2 + 2NH_3 = NH_2Hg_2Cl + NH_4Cl$$

When ammonium sulphide is used instead of ammonia, the calomel is split up into mercuric sulphide and finely-divided mercury, and the silver chloride is also converted into a form of silver sulphide.

Fixing the Image.—After the development of the latent image

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[*] *Photographic Journal*, 1877, page 41.

[†] *Photographic News*, 1876, page 123.

or picture formed upon the sensitive film, the silver iodide and bromide are left unaltered.

Looking at the reverse side of the plate (that which does not bear the film), the yellow colour of the iodide and bromide of silver will be apparent.

Were the unaltered iodide and bromide left in the film, a print taken from such a plate would be found to be nearly a blank, as these bodies possess almost as much power of preventing the passage of light as the reduced silver itself. There are certain chemical compounds which, in solution, are capable of converting them into soluble compounds. When such compounds are applied they leave the metallic silver unchanged. These solvents are termed "*fixing agents*," and the operation of dissolving out the silver iodide and bromide is termed "fixing the image." Dismissing the chlorides of the alkalies and potassium iodide (owing to their imperfections as fixing agents), the solvents of iodide, bromide, or chloride of silver that are to be noticed are sodium hyposulphite ($Na_2S_2O_3$),* and potassium cyanide (KCN or KCy).

The following is the chemical reaction of the cyanide on silver iodide :—

Silver Iodide and Potassium Cyanide give Double Cyanide of Silver and
$$AgI + 2KCy = AgKCy_2 +$$
Potassium Iodide
$$KI$$

If bromide or chloride be substituted for the iodide, the same reaction occurs.

Potassium cyanide† has also a slightly solvent power on finely-deposited metallic silver. If a test-tube be coated with a fine layer of metallic silver (see "Silvering Mirrors," in Appendix), it will be found that a strong solution of the cyanide will completely dissolve it after a short interval of time. From this simple experiment we learn the necessity of using a weak solution of this fixing agent, and allowing it to remain on the plate as short a time as possible, since the image is metallic silver in a very fine state of division, more particularly in the half-tones.

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* More correctly called the thio-sulphate.

† The potassium cyanide is a *deadly* poison, and great caution should be exercised in working with it. Its fumes are deleterious to the system, and if the solution come in contact with a cut or sore place in the skin, festering is liable to occur.

With gelatine plates the deposit is so fine that this agent is generally avoided, though it may be used weak and with caution.

Most photographers recommend the hyposulphite, in preference to the cyanide, as a fixing agent for negatives, owing to the latter's poisonous character and liability to eat into the half-tones. The colour of the negative given by the latter by reflected light is whiter, but by transmitted light browner, and, consequently, more non-actinic than if the former be used. If ordinary precautions are taken, cyanide need not prove hurtful to the operator through inhalation or otherwise; and if the films which will stand cyanide (such as a wet plate) be washed *immediately* after the haloids of silver are dissolved out, there need be no fear of an attack on the half-tones.

Great care should be taken that no acid come in contact with the cyanide solution, as it is decomposed, and hydrocyanic acid vapour (prussic acid) is given off. The vapour is almost more dangerous than the liquid solution.

In fixing prints, sodium hyposulphite is almost invariably used as the fixing agent, and a strong solution is necessary to secure permanency of the print. The reason of its use is that cyanide will dissolve the silver oxide formed in organic silver compounds used, whereas hyposulphite does so only slowly; and the reason why a strong solution of the latter should be used is that there are two silver hyposulphites which can be formed:—

$$\overset{\substack{\text{Silver}\\\text{Chloride}}}{AgCl} + \overset{\substack{\text{Sodium}\\\text{Hyposulphite}}}{Na_2S_2O_3} = \overset{\substack{\text{Double Hyposulphite}\\\text{of Silver and Sodium}}}{AgNaS_2O_3} + \overset{\substack{\text{Sodium}\\\text{Chloride}}}{NaCl}$$

and

$$\overset{\substack{\text{Silver}\\\text{Chloride}}}{2AgCl} + \overset{\substack{\text{Sodium}\\\text{Hyposulphite}}}{3Na_2S_2O_3} = \overset{\substack{\text{Hyposulphite of}\\\text{Sodium and Silver}}}{Ag_2Na_4 3(S_2O_3)} + \overset{\substack{\text{Sodium}\\\text{Chloride}}}{2NaCl}$$

If silver iodide or bromide be substituted for the chloride, the same reactions will occur.

The first double hyposulphite is nearly insoluble in water; the last is highly soluble. These two salts may be formed for experiment, in the first case by adding an excess of silver nitrate to the sodium hyposulphite solution, in the other by adding a large excess of the latter to the former. With the first we have a dirty-brown precipitate; with the latter there will be a perfectly clear solution. The student is recommended to try the experiment.

CHAPTER IV.

PHENOMENA IN DEVELOPMENT.

It is now proposed to enter briefly into certain phenomena which present themselves in the development of the photographic image.

It will be seen in the wet plate process that it is necessary, 1st, to use a collodion which contains free iodine; and 2nd, to use a bath slightly acidified. Ordinary iodized collodion, such as is ready for use, contains a soluble iodide, a little soluble bromide, and rarely some chloride; and in the instructions issued with commercial collodions it will be seen that it is recommended to add tincture of iodine (iodine dissolved in alcohol) till it assumes a golden-sherry colour. Let us trace what will happen when such a collodion is immersed in the bath.

It is a known fact that if you have silver chloride in contact with a soluble bromide, silver bromide will be formed, leaving a soluble chloride behind.* Thus:—

Silver Chloride and Potassium Bromide

$$AgCl + KBr$$

give Silver Bromide and Potassium Chloride

$$= AgBr + KCl$$

Again, silver iodide will be formed if a soluble iodide be present with either silver chloride or bromide, or both. Thus, when a plate is coated with collodion, the iodide will first of all be formed, and then the bromide, and finally the chloride. The free iodine will at the same time also form iodide and iodate of silver, and liberate in the film a little nitric acid, thus:—

Iodiine and Silver Nitrate give Silver Iodide, Silver Iodate, and Nitric Acid

$$6I + 6AgNo_3 = 5AgI + AgIO_3 + 6HNO_3$$

The question arises as to the use of this reaction. If we use potassium iodide in the collodion we shall find that, as a rule, it

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* Field and Maxwell Lyte first investigated this reaction.

has an alkaline reaction, turning reddened litmus paper blue. Pure potassium iodide should be perfectly neutral, but it can well be understood how the alkaline reaction might arise. If, for instance, the iodide be slightly moist (moisture from the surrounding air is sufficient), we have then a body sensitive to light. Dr. Leeds has shown that the following reaction may take place:—

Potassium Iodide	and	Water	and	Oxygen	give	Iodine	and	Potash
$2KI$	$+$	H_2O	$+$	O	$=$	21	$+$	$2KHO$

The iodine volatilizes, and we have potash or potassium hydrate left behind. In this way, then, the iodide may be alkaline. Suppose, now, we have iodine added to such an iodide, we have the following:—

Iodine	and	Potash	form	Potassium Iodide,		Potassium Iodate,	and	Water
$6I$	$+$	$6KHO$	$=$	$5KI$	$+$	KIO_3	$+$	$3H_2O$

The addition of iodine thus insures the absence of all alkalinity from a collodion. If it were alkaline, silver oxide would be precipitated, and would form a nucleus on which development would take place. Iodine thus secures freedom from what is called fog, which is a precipitation or reduction of silver in parts of the plate which have not been acted upon by light.

The next point is regarding the acidity of the bath solution. It may safely be said that if the collodion be in proper working order, no acidification of the bath should be necessary. It must not be forgotten, however, that pyroxyline is not always an innocuous substance; it sometimes contains matter which is liable to reduce silver nitrate to the metallic state, when the silver nitrate is absolutely neutral; if, however, the silver nitrate be acid, such a reduction is almost impossible. Again, too, by keeping in the presence of iodides and bromides and free iodine, one of the collodion solvents is apt to be partially reduced to the state of aldehyde, which reduces silver nitrate to the metallic state when in a neutral condition, and the small particles of silver so reduced would cause a veil. The addition of acid, particularly nitric acid, to the bath, entirely prevents this. Hence, for safety's sake, the silver bath should be just *not* neutral, but slightly acid.

When emulsions in gelatine or collodion are formed, the same reactions indicated above hold good; that is to say, fog or veil might be expected if the whole of the soluble haloid salts were converted into the respective silver haloids. Besides an alkaline reaction, however, it may happen that the salt employed contains portions which are not fully saturated with the halogen (iodine, bromine, &c.), in which case we should have the formation of a silver sub-haloid. Thus with copper, the saturated bromide is cupric bromide ($Cu\,Br_2$); it is sure to happen that cuprous bromide ($Cu\,Br$) would also be present, in which case, on the addition of silver nitrate, we should have the following—

Cuprous Bromide and Silver Nitrate form Silver Sub-bromide and Copper Nitrate

$$Cu\,Br + 2Ag\,No_3 = Ag_2\,Br + 2Cu\,No_3$$

Thus we should have the same salt formed chemically which is formed physically by the action of light on silver bromide, and again we should have fog on the development of plates prepared with such a compound. The question is, how can such be eliminated or altered so as to be non-injurious? Acid will do it, more particularly nitric acid, for then we probably get the following reactions :—

Silver Sub-bromide and Nitric Acid form Silver Bromide, Silver Nitrate, Nitrous Acid, and Water

$$4Ag_2\,Br + 6HNO_3 = 4Ag\,Br + 4AgNO_3 + N_2O_3 + 3H_2O$$

If hydrochloric acid be added, we have a simpler reaction, which is the formation of silver bromide and hydrogen. Another means exists of getting rid of the sub-bromide, which is to add iodine or bromine to the emulsion, forming a bromo-iodide of silver in the one case, and bromide in the other. By adding an oxidizing agent to it, we also eliminate the sub-bromide, or rather, render it undevelopable. Thus we find that permanganate of potash, bichromate of potash, ozone, and peroxide of hydrogen destroy the sub-bromide as far as its developing powers are concerned, the exact reaction that takes place being somewhat uncertain. Again, any body which will readily give up a halogen is a certain eliminator of the evil arising from the chemically formed sub-bromide. Thus, cupric bromide or chloride will give up an atom of bromine or chlorine to the silver sub-bromide.

Cupric Bromide and Silver Sub-bromide yield Cuprous Bromide and Silver Bromide

$$CuBr_2 + Ag_2\,Br = Cu\,Br + 2Ag\,Br$$

When, however, an adulterated soluble haloid (and when we say adulterated, we mean one which contains some adulteration which, when placed in silver nitrate, would cause the formation of fog or veil on a plate) has to be employed, and it is so managed that the silver nitrate is less than that required to convert both the haloid and its adulteration into a compound of silver, it will be found that the adulteration is last to be formed, and that the haloid will be pure. Thus, then, we have another plan to prevent the formation of the fog-giving salt of silver, by keeping the silver nitrate in defect. This is a most important proposition to establish, since the possibility of a gelatine emulsion depends on its application.

Both sides of the advisability of using an excess of soluble haloid must, however, be looked at. We have seen that potassium iodide will in the light liberate iodine in presence of oxygen, and this is yet more so the case when it is also in the presence of metallic silver, or an unsaturated compound of silver, such as the sub-iodide, and the action of light on potassium bromide under the same circumstances is precisely the same. And we have also seen that the silver sub-salt is destroyed by iodine or bromine. Suppose we have silver bromide and potassium bromide exposed to light together; then, as fast as the silver sub-bromide is formed, it has a tendency to be destroyed by the potassium bromide splitting up into bromine and other compounds; so that the real sensitiveness of the mixture depends on the difference in sensitiveness of the silver bromide and potassium bromide. It is thus evident that the sensitiveness must be less than when the silver bromide alone is present. There is another phenomenon with which this destruction of the sub-salts of silver, and, consequently, the destruction of the developable image, is connected; and that is, the reversal of the image, or *solarization*, as it used to be incorrectly called. Solarization of the most aggravated type means the formation of a positive picture on development, instead of a negative image. In the early days of photography with collodion, when merely iodide of silver was used on which to impress the developable image, this (apparently) strange phenomenon was often encountered. In a landscape negative, whilst the rest of the picture would have its proper gradations, the sky would appear as eaten out, and nearly a blank, with scarcely any deposit of silver, any small deposit taking a rather roseate hue. When bromide was added to the iodide, the defect was rarely met with in wet plates; though, in the case of interiors, when a window illuminated with bright light, and dark parts immediately near it, had to be pourtrayed on the same plate, the defect was still to be found. With collodion dry plates in which preservatives are used, the phenomenon was still more rare; but with gelatine plates its occurrence is by no means uncommon. Let us endeavour succinctly to show what is the cause of this. First, with wet plates; experiment has shown that sub-iodide of silver is more readily oxidized than the bromide, and it is for this reason that solarization was more frequently met with in the case of this salt than with the bromide. Let the reader bear in mind the action that takes place when silver iodide is exposed to light in the presence of silver nitrate. A reference to page 3 will show that nitric acid, iodate of silver, and silver iodide is formed. Prolonged action of light will use up the free silver nitrate which may be in contact with the silver iodide, and leave merely nitric acid and silver iodate to be acted upon. The action of the nitric acid on iodide subsequently liberated is to oxidize it, and that destroys the developing power of the iodide.

When bromide is used as well as iodide, the nitric acid has a direct action on it; but when used in combination with the iodide, the sub-bromide formed by light acts as an absorbent of iodine when all the free silver nitrate is exhausted. When a proper preservative is used, in an alkaline condition more especially, it absorbs both iodine and bromine, and hence solarization or reversal of the image takes place with greater difficulty. It must be remarked, however, that to be effective, it is almost a *sine qua non* that some moisture be present, as a thoroughly dry preservative can only very slowly combine with iodine. Any organic substance, when it combines with a halogen, does one of two things, as already pointed out in page 3. The one atom of the halogen takes the place of a hydrogen, and another combines with this hydrogen to form an acid, or else the halogen takes the place of what is called a hydroxl group (HO).

We may represent the action of bromine, for instance, on two such substances as follows:—

An Organic Compound and Bromine yield Organic Bromide and Hydrobromic Acid
(1) $C_nH\ O_p + 2Br = C_nH_{m}\text{-}_1OBr + HBr$
Acid Organic Compound Bromine yield Organic Bromide and Hydroxl
(2) $C_nH_yO_zHO + Br = C_nH_yO_zBr + HO$

In (1), hydrobromic acid is a strong destroyer of the developable image, and such a preservative is likely to yield plates which will not keep unless some body be present to combine with it and render it innocuous—an alkaline carbonate, such as soda, will answer the purpose. This is the condition of most collodion dry plates, hence solarization with them is less common.

In (2) we have, in all probability, the condition of a gelatine film; that is, that the bromide, when coming in contact with gelatine, liberates hydroxyl or peroxide of hydrogen. This, as is well known, is a very strong oxidizer, and it will oxidize the neighbouring molecule of gelatine, or else the silver subbromide, and so produces an undevelopable image. We need only point out that some such action as this must occur, since in a gelatine plate exposed to direct action of light so as to show a strong image, the gelatine becomes more insoluble in the parts acted upon by light than in those where no exposure has taken place.

This will readily account, then, for the reversal of the image in a gelatine plate. If a gelatine or other plate be soaked in potassium nitrite or sodium sulphite, each of which is a strong bromine absorbent, it may be exposed for almost an unlimited time, and no reversal will take place. The reversal of the image on a film supported on glass is of a much more aggravated character than when a paper support is used, such as in Warnerke's gelatino-bromide paper. This is due to the fact of halation taking place at the same time, the halation forming a background on which the reversed image is more readily distinguished. In our next chapter we shall treat of this halation. As will be gathered from the beginning of the chapter, a silver haloid precipitated in the excess of soluble haloid is more liable to reversal than one which is not so prepared, as the soluble haloid is sensitive to light. Not only are the rays which affect the haloid salts of silver effective in acting on the soluble haloid,—such as potassium bromide—but also the red rays.

The following diagram taken from a paper in the *Philosophical Magazine*, by the author, in 1880, will show what rays are active in causing reversal.

Fig. I. shows the action of a spectrum on a film containing silver iodide which had been exposed to light, and then treated with potassium iodide.

Fig. II. shows the same plate, only treated with potassium bromide, by which it will be seen that the red and yellow rays are active in causing reversal.

Fig. III. is the same plate when exposed to the spectrum in the presence of potassium bichromate. Here we have the red and yellow rays only active.

Fig. IV. shows the same plate exposed with permanganate of potash present; and—

Fig. V. shows it when exposed in the presence of hydroxyl peroxide (of hydrogen); while—

Fig. VI. shows the action of mineral acids or silver iodide during exposure. We next come to the bromide films.

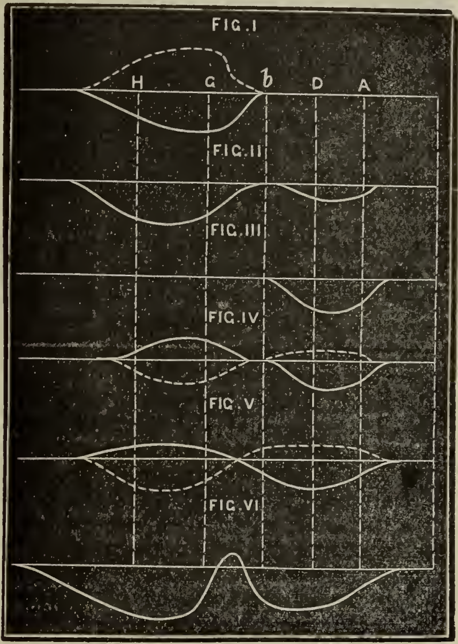


Fig. VII. shows the action of the spectrum on a bromide film—after being exposed to light—in the presence of potassium bromide.

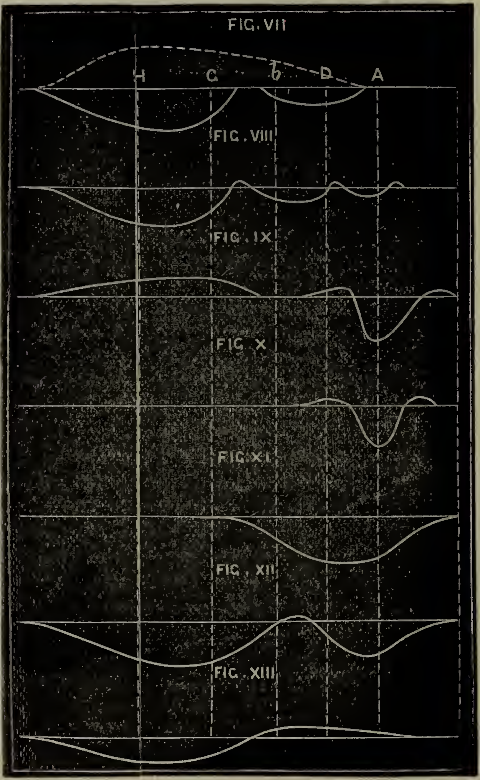
Fig. VIII. is the same plate, but exposed in an alkaline solution of potassium bromide.

Figs. IX. and X. show the effect when the bromide is exposed in the presence of potassium permanganate and of potassium bichromate respectively.

Fig. XI. shows the action on a gelatine plate when exposed in the presence of the bichromate.

Fig. XII. shows the effect of mineral acids (such as nitric acid) in causing reversal.

Fig. XIII. shows the ordinary reversal of the image on a gelatine plate.



A study of these figures will repay the reader who is interested in knowing the why and the wherefore of this strange phenomenon, and it will be apparent that not only have the blue rays to be reckoned with, but also those rays which are usually supposed to have no chemical effect. In both diagrams the height of the curve below the horizontal line shows the intensity of the reversal, the heights above the line showing the ordinary negative image. The dotted curves show variations in the phenomena by varying the exposure.

CHAPTER V.

HALATION.

One of the phenomena met with in photography is a blurring of the image; for instance, in a landscape, an encroachment of the high-lights on a darker portion next to it will take place. In photographing interiors of buildings, in which there is often a bright light streaming through a window, this effect is markedly seen; also when exposing a plate in the direction of the sun, where the direct rays enter the lens. The subject has been investigated by the writer on two occasions—once in 1875, when treated mathematically in the *Philosophical Magazine*, and again in 1881, in a more popular manner, before the Photographic Society of Great Britain.

Halation is really caused by reflection from the back of the glass plate. Rays of light entering a film are scattered by the particles of the silver salt, and obey certain well-known optical laws. More rays are reflected back at what is known as the critical angle of the glass than at any other part. Thus, a dot will be surrounded by a circle (fig. 5). A line will show a halo (as in fig. 6), and this can be shown to be built up of a series of circles (fig. 7). A cross can then be traced to the figures surrounding two lines at right angles (fig. 8). Again, by increasing the thickness of the plate, the figure is seen to be

Fig. 5.

extended (fig. 9), as should be the case as required by theory. The image of a disc will be surrounded by a halo encroaching

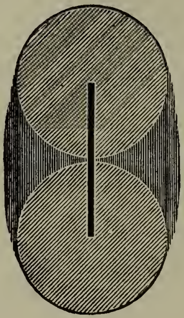


Fig. 6.

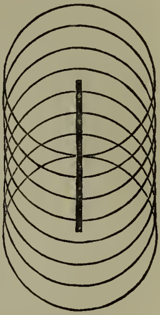


Fig. 7.

up to its edge (as shown in fig. 10), and this, again, can be

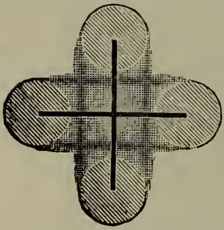


Fig. 8.

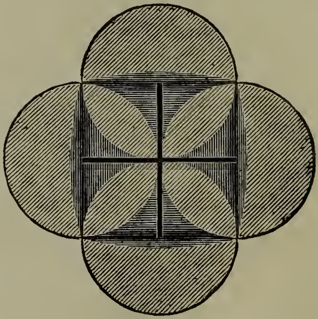


Fig. 9.

shown to be built of a series of circles formed by every point in the disc, as can the image of a triangle (fig. 11).

Fig. 10.

Fig. 11.

It will thus be seen, if we can get something which will not reflect at all, or which will only reflect rays which are chemically inactive on the salts of silver, that such halation can be done away with entirely. In dry-plate processes, it will be noticed that what is called a backing is recommended to be used, and the sole reason for its use is that the reflection from the back of the plate is, at all events, lessened. In the previous chapter we remarked that the reversal of the image appeared to be aggravated by halation, and it will now be seen for what reason.

The scattered light, after passing through a film, is much reduced in intensity. It therefore follows that the time necessary to cause a reversal of the halation is vastly greater than that necessary to cause a reversal of the actual image. Thus we get the feeble image caused by reversal, lying on a background which is not at all, or only slightly, reversed. Of course, when proper backing is used, there is no reflection, and the reversal is less evident. We may also here remark that, in a paper negative, the halogen liberated by light has two surfaces from which to escape, and consequently there is, on this account, a less chance of a reversal taking place. The great desideratum in a backing is that it should reflect none, or, at all events, only inactive rays, and that it should be in absolute (optical) contact with the back of the plate.

The more absolutely transparent a film is, the less chance there is of blurring, since the particles seem not to be of sufficient size to scatter the light. It should be noted that in some dry plate processes the preservative used has a tendency to cause halation, which is due, in a great measure, to the action of the preservative itself—that is, the particles of preservative scatter the rays; whilst with the same film another preservative would entirely do away with the necessity of any backing whatever. With a wet plate, the particles of liquid lying in the film scatter the light and give rise to halation, but the emulsion processes are those which are most prone to show it in its worst form. An exact estimate of the amount of blurring that may be expected may be formed by cutting out in tinfoil a straight line of about one-fiftieth of an inch in width, and then placing it in contact with the film on the prepared plate. If the line be looked at through the film in a moderately bright transmitted light, it will be seen surrounded by a halo (as in fig. 6) in exact proportion to the amount of rays scattered by the film.

CHAPTER VI.

PYROXYLINE.

Collodion is a viscous fluid made by dissolving gun-cotton (*i.e.*, pyroxyline) in a mixture, varying in proportions, of alcohol and sulphuric ether, and is employed in photography as a vehicle in which the sensitive salts of silver are held for the purposes of exposure in the camera, &c. It is employed by pouring it over a glass plate, so as to form a film, by the method described in Chapter VIII. Collodion should be limpid, structureless, and should possess a certain amount of tenacity; it should be non-contractile, and be perfectly transparent when dry. All of these qualities may be present or absent, according to the kind of pyroxyline used. We propose to show how to prepare pyroxyline.

Pyroxyline is cotton or fibre (cellulose or lignine) which has been altered in chemical composition by treatment with a mixture of nitric and sulphuric acids, or an equivalent of the former. The change that takes place is due to the combination of nitrogen tetroxide with the cellulose or lignine. The chemical action may be symbolized as follows:—

$$\overset{\text{Cotton}}{C_6H_{10}O_5} \overset{\text{and}}{+} \overset{\text{Nitric Acid}}{2H.NO_3} \overset{\text{and}}{+} \overset{\text{Sulphuric Acid}}{H_2SO_4} \overset{\text{form}}{=} \overset{\text{Pyroxyline,}}{C_6H_8(NO_2)_2O_5}$$

$$+ \overset{\text{Sulphuric Acid, and Water.}}{H_2SO_4 + 2H_2O}$$

It will be noticed that the sulphuric acid remains unchanged. Its use is principally dependent on its affinity for water. Hydrogen from the cotton is abstracted, and combines with the oxygen liberated from the nitric acid. This forms the water which the sulphuric acid absorbs. The formula shows that two equivalents of hydrogen are displaced by two equivalents of nitric peroxide. When three equivalents are displaced we have the true explosive gun-cotton. The difference in the temperature of the acids, &c., determines whether tri-nitro or di-nitro (pyroxyline) cellulose is formed.

The manufacture of pyroxyline is one of considerable difficulty, though not at all out of the range of ordinary skill. For amateurs the second process will, it is believed, be the most useful. The general directions given are those found in Hardwich's Photographic Chemistry. A method of preparing pyroxyline suitable for some kinds of dry-plate processes is given at page 32.

1st Process.—	Sulphuric acid 1·845 at 60° F.	18	fluid ounces*
	Nitric acid 1·457	6	,,
	Water	4¾	,,
Or,	† Sulphuric acid 1·845	18	fluid ounces
	Nitric acid 1·45	6½	,,
	Water	4¼	,,

The water is first poured into a strongly-glazed porcelain basin, the nitric acid *next* added, and, *lastly*, the sulphuric acid. The mixture is well stirred with a glass rod. The temperature will now be found to be somewhere about 190°. It must be allowed to cool to 150°, and this temperature must be maintained on a water-bath. A dozen balls of cotton-wool, weighing about thirty grains, should now be immersed separately in the fluid with the aid of a glass spatula. The cotton-wool ordinarily obtained in commerce is contaminated with resinous matter of a varying character. In order to eliminate this source of uncertainty, the cotton is well boiled in an alkaline carbonate (such as sodium carbonate), then *thoroughly* washed, and, finally, carefully dried.‡ In this state, if dropped into water, it will rapidly sink, whilst cotton-wool in its ordinary conditionwill float on the surface for

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* It need scarcely be said that great care must be taken to prevent the acid coming in contact with the skin or dress. An india-rubber apron and pair of gloves are useful to save the one and the other from hurt.

† The nitric acid of the strength given in this formula is cheaper than that of the first, and is of the standard strength; hence it is recommended for economy's sake to use it.

‡ Strutt's prepared cotton as for dentists may be used without further preparation. It has been freed from grease by steam under high pressure.

an almost unlimited time. Each ball of cotton should be pressed separately against the sides of the basin till it is evident that the acids have soaked into the fibre. Care must be taken that each one is immersed at once. Failing this, a different chemical combination takes place, and nitrous fumes are given off, and the success of the operation will be vitiated. Immersing the dozen balls will take about ten minutes. The basin after this should be covered up for about ten minutes.* At the expiration of this time the whole of the cotton should be taken up between two glass spatulas, and as much of the acids as possible should be squeezed out against the sides of a clean porcelain capsule. The cotton should then be dashed into a large quantity of water, and washed in running or frequent changes of water for twenty-four hours. Finally, when it shows no acid reaction to blue litmus paper, it is dried in the sun or on a water-bath.

2nd Process.—	Sulphuric acid of commerce ...	6 fluid ounces
	Dried potassium nitrate ...	3½ ounces (Av.)
	Water	1 fluid ounce
	Prepared cotton wool	60 grains

Mix the acid and water in a porcelain vessel, then add the nitrate (which has previously been dried on a metal plate to about 250°, and then pulverized) by degrees, stirring with a glass rod until all lumps disappear, and a transparent viscous fluid is obtained. This will occupy several minutes.

The whole of the cotton wool must now be separated into balls the size of a walnut, and immersed as stated in the first process, care being taken that the temperature is kept up to 150°. The cotton is then left ten minutes, and washed as before. Mr. Hardwich states that the chances of failure in this process "are very slight, if the sulphuric acid be sufficiently strong, and the sample of nitrate not too much contaminated with potassium chloride." If failure occur through the cotton dissolving in either of the mixtures, a drachm less water must be used.

In both processes the operation may be conjectured to be successful if the cotton tear easily in the hand, and if the original lumps cannot be easily separated. Should nothing but frag-

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* This prevents the access of the air to the fluid, and consequent absorption of oxygen. A neglect of this precaution will increase the chance of nitrous fumes being evolved.

ments of the lumps be detected, it is probable (if the acids used have been of the strength given above) that the temperature has been allowed to fall. When dry, the pyroxyline, on pulling by the hand, should break up into little bits, and not resemble the original cotton in texture.

The weight of good pyroxyline should be greater than the original cotton by about 25 per cent.

If the acids employed be too strong, the pyroxyline will have a heavier percentage of gain, and on solution yield a thick glutinous collodion; whereas, if the acids have been too diluted, it will probably weigh less than the original cotton, and yield a collodion adhering firmly to the plate, but giving negatives of an abnormal softness; with this specimen any small particles of dust that may fall on the glass will form transparent marks. The formula given about steers between the two extremes. For emulsion processes a less tenacious pyroxyline is considered desirable, so we give some formulæ here:—

The late Mr. G. W. Simpson described a modification of Hardwich's formula, which has given excellent results in our hands; the mode of procedure is the same as that described above. The following is an extract taken from the PHOTOGRAPHIC NEWS:—"In our practice, we found Hardwich's formula to contain too large a proportion of water, and our experiments with it issued in something like 50 per cent. of failures, the cotton dissolving almost entirely in the acids. We may add a formula which we have found to give an excellent sample of soluble cotton for emulsion work, the collodion holding the particles of silver salt well in suspension, and giving a homogeneous film, adhering well to the glass. The formula we subjoin has the advantage that the acids are readily obtainable in commerce of the strength we mention, and are consequently cheap. Six measured parts of sulphuric acid 1·840 (ordinary commercial oil of vitriol will serve), and four measured parts of nitric acid 1·360. This is the strength of acid commonly sold as a pure nitric acid. In three measured ounces of the mixed acids, one drachm of cotton wool should be immersed at a temperature of 150° Fah., using a water bath to maintain that temperature for ten minutes, when the cotton should be removed and washed at once in a large quantity of water."

In the next formulæ the proportion of sulphuric acid is diminished, and in consequence we get a pyroxyline which is, if anything, deficient in tenacity. For dry plate processes with the bath, however, it is excellent, and will be found of great use in emulsion processes in which a preservative is used. The formulæ are those given by Warnerke in a communication to the Photographic Society of Great Britain made in 1876.

His *modus operandi*, based on a communication made to him by Colonel Stuart Wortley, is the following:—100 grains of the finest cotton wool are put into a porcelain jar, and 30 grains of gelatine dissolved in the smallest amount of hot water are added. By pressing it with a wooden stick, all the cotton will be uniformly impregnated. It is subsequently very thoroughly dried before the fire.

Nitric acid (sp. gr. 1·450)	4 fluid ounces
Water	12½ drachms
Sulphuric acid (sp. gr. 1·840) ...	6 fluid ounces

are mixed in the order named. An arrangement is provided to keep the temperature of the mixture uniformly at 158° Fahr. The dried gelatinized cotton, weighing now about 130 grains, is immersed in the mixed acids, and left in twenty minutes. After the lapse of this time the acids are pressed out, and the pyroxyline quickly transferred to a large vessel of water. Washing and drying follow. Colonel Stuart Wortley recommended also a second mode. Gelatine, instead of being added to the cotton, is dissolved in the water figuring in the formula of the acids, and ordinary dry cotton immersed in the mixture of gelatinized acids.

Mr. Warnerke states that before washing the gelatinized emulsion a remarkable increase of intensity and sensitiveness is obtained. After washing, the difference is less striking, but still sufficiently marked to prove the new pyroxyline to be a very decided improvement.

Mr. Warnerke also states that pyroxyline giving extraordinary density can be prepared from the raw hemp. Collodion from hemp-pyroxyline is red in colour, and very fluid; but the insoluble deposit is very considerable; it also requires stronger acids. It is worth remarking that the strength of acids must vary with different samples of fibres, even in the case of different cottons. A very good pyroxyline can be prepared from Whatman's hand-made paper, instead of the cotton in the above formula, which, being sized with gelatine, offers a ready-made material, suitable for making gelatinized pyroxyline."

The great difficulty in this formula is the easy solubility of the cotton at the high temperature. A reduction in the amount of water will prevent this. *Pyroxyline from ordinary cotton can be prepared by the same formula*, and gives a powdery film.

Dr. Liesegang introduced a form of pyroxyline called papyroxyline. It is prepared from paper instead of cotton, and its value for giving tough films is great. Dr. Liesegang thus prepares it :—He takes equal measures of nitric and sulphuric acid as above, and when cooled he immerses thin paper in the mixture (we believe, white blotting-paper or Japanese paper), and keeps it immersed for five hours. He then takes a portion out which he washes and dries, and sees if it dissolves readily in equal parts of ether and alcohol. If it does, he washes the whole; if not, he leaves it longer, till the desired solubility is obtained. Four grains of papyroxyline are equivalent to five of pyroxyline. A judicious mixture of the two in the solvents gives highly satisfactory results.

We cannot help calling attention to a cotton prepared by Messrs. Anthony, of New York, called No. 1 soluble cotton; it is admirable for nearly every purpose.

CHAPTER VII.

PREPARATIONS FOR WET PLATE PHOTOGRAPHY.

It is now proposed to describe in detail the process commonly known as the collodion wet process. The sensitive salts of silver usually employed in this process are the iodide and bromo-iodide, the former being used only for special classes of work, to which attention will be drawn. The following is an outline of the process :—1st. Collodion is prepared in which are dissolved bromides and iodides. 2nd. A clean glass plate is coated with a thin film of this prepared collodion. 3rd. When set, the plate is immersed in a solution of silver nitrate (usually called the bath solution), which causes the formation of silver iodide or bromo-iodide. 4th. The plate is then exposed in the camera. 5th. A developing solution is applied to bring out the image. 6th. The image is intensified or strengthened. 7th. It is fixed. And 8th a coating of varnish is given to the dried film to protect the delicate collodion surface. In this stage the negative is complete for printing purposes.

The Glass Plate.—A few remarks are necessary on the glass that should be selected for camera work. As a rule, patent plate is recommended by most authorities on the subject, as being perfectly flat and of a good polish. It must, however, be borne in mind that patent plate is really nothing more than sheet glass which has been ground to a flat surface and then polished. The outer skin of all glass is always the hardest and most compact portion, and since the patent plate is denuded of much of the original surface, the inner portions of the sheet glass are consequently exposed to the action of the chemicals employed. In practice it is found that this glass absorbs impurities, during the photographic operations, which cannot be eliminated; and it is almost useless to expect to use the same plate above three or four times, a serious consideration to the tyro in the art when the high price of the article is remembered.

Sheet glass is generally "true" in one direction, but slightly curved in the other, but its surface is hard and well adapted for small-sized plates, where the curvature may be neglected. A good specimen of this glass is one to be recommended.

Crown glass, from the nature of its manufacture, has generally double curvature, and is to be employed for large plates with great caution, owing to its liability to snap in the printing frame, and to throw portions of the picture out of contact.

Flatted crown is not open to this objection, but if it be really flatted its cost should be nearly that of patent plate. It has a hard surface, and when a true sample of it is to be obtained, there is nothing better that can be used.

For large plates, say over 15 in. by 12 in., patent plate is recommended; for the inferior sizes, flatted crown; or, failing this, the best sheet glass.

Flatted crown has only one surface that is smooth, the process of flattening (which consists in heating the ordinary crown to a red heat and allowing it to flatten on a plain surface) making the other slightly irregular.

Plate-Cleaning Solution.—In order to make a plate chemically clean, some body must be found which will free it from mechanical dirt—such as dust—and also from grease. Alcohol has the property of holding most kinds of the latter in solution, hence it generally forms the staple of a plate-cleaning formula. Any alkali will turn grease into soap, rendering it soluble in water; hence this is often recommended as an addition. To free a plate from mechanical dirt, insoluble powder of an impalpable description is found to answer well when made up in a paste, hence the employment of tripoli powder and rouge. Common whitening has the property of absorbing grease when dry; hence a cream of this made up with water is sometimes applied to a plate, allowed to dry, and rubbed off in that state. The usual formula for a plate-cleaning solution is tripoli powder; spirits of wine sufficient to form a thin cream; liquor ammonia about ten drops to each ounce of the cream. Rouge may be substituted for the tripoli powder, but unless it be of the finest nature, it is liable to cause scratches. It has also the disadvantage of injuring the bath if any be carried into it by the plate.

Plates carrying old varnished negatives, which are to be used again, should be allowed to soak in soda and water (one ounce of washing soda to two pints of water). This will generally secure the film leaving the plate. Should the films be unvarnished, hot water may be employed to remove the collodion. In both cases the plates must be treated with the cleaning solution.

It may happen that plates are slightly scratched, and refuse to become clean by ordinary means. Resort may then be had to albumen, &c., as given for dry plates.

Collodion.—In Chapter VI. we have already stated the qualities necessary in collodion, and the following are formulæ which experience has shown are good proportions for solvents.

No. 1.—	Pyroxyline	55 to 65 grains
	Alcohol ·820	4½ ounces
	Ether ·725	5½ ,,
No. 2.—	Pyroxyline	55 to 65 grains
	Alcohol ·820...	5 ounces
	Ether ·725	5 ,,

No. 1 is most suitable for winter; No. 2 for summer work. The more alcohol in proportion to the ether that is used the slower will the collodion set. A limit, however, to the proportions that can be used arises from the fact that if the alcohol be added in excess, the film which contains the sensitive salts of silver becomes streaky, and slow in securing the impressions of the photographic image; whilst if there be an excess of ether the film becomes too contractile, and has a tendency to split on drying. In mixing the collodion the alcohol should be added first to the pyroxyline, as by so doing its solution is aided. It must also be remembered that the quantity of pyroxyline given above is dependent upon its quality, viz., if it tend to form a gelatinous or limpid collodion. In the former case, less must be used; whilst in the latter, more may be added.

When plain collodion has been prepared, and is poured in a fine stream into water, it is found that a portion of the pyroxyline remains in solution in the water, the precipitated portion being of a finer quality than the original. If this be dried and made up into collodion once more, it yields a beautifully textureless film. Should this method of "refining" the pyroxyline be determined upon, cheaper solvents, and half the quantities given, may be employed in the first instance.

Iodides and bromides of metals or alkalies are added to the plain collodion, and when a film of this bromo-iodized collodion is formed on a plate, and then immersed in a solution of silver nitrate, a fine layer of silver iodide and bromide is formed. If iodides are used alone, the developed image is usually dense, with but little detail in the high-lights or shadows. The fact is, that in the high lights the detail is present, but is clogged by silver deposit, which is due to the prolonged exposure which is necessary to give detail in the shadows. In the deep shadows the light reflected is, as a rule, less blue than in the high-lights, as it is usually reflected not from the sky, but from other portions of the object to be photographed. By reference to page 5, fig. 2, it will be seen that whilst the iodide is extremely sensitive to the violet rays, it is almost insensitive to a really blue ray. Bromides used by themselves give a flatter image, but, as might be expected, full of detail, and the time required to impress a latent image on the sensitized film is shorter than when iodides alone are employed. It is thus evident that a judicious mixture of the two will give a film which, when sensitized, gives a mean between the delicacy of the bromide and the density of the iodide, whilst the time of exposure will be somewhat between that required for the two separately.

There is no doubt that the effect of different metals in combination with the halogen has some effect on the qualities of the collodion. Thus, ferrous bromide has a tendency to cause the pyroxyline to revert to its original state of cotton. It is therefore evident that, in choosing iodizers, this must be taken into account.

The iodides and bromides of zinc, potassium ammonium, and cadmium have all been tried by various makers. The two last are the staple iodizers and bromizers employed.

The following list may be useful in showing the amounts of iodine or bromine in the iodides or bromides of certain of the metals, &c. Of others, the amounts can be calculated from the table in the Appendix:—

In 10 grains of		potassium iodide	there are	7·6455	grains of	iodine
,,	,,	,, bromide	,,	6·7164	,,	bromine
,,	,,	cadmium iodide	,,	6·9398	,,	iodine
,,	,,	,, bromide	,,	5·8823	,,	bromine

In	10 grains of	ammonium iodide	there are	8·7586	grains of	iodine
,,	,,	,, bromide	,,	8·1632	,,	bromine
,,	,,	magnesium iodide	,,	9·1366	,,	iodine
,,	,,	,, bromide	,,	8·6945	,,	bromine
,,	,,	zinc iodide	,,	7·9608	,,	iodine
,,	,,	,, bromide	,,	7·1092	,,	bromine

A standard iodizing solution having been arrived at by experiment with any of the iodizers and bromizers given above, the value of others may be determined.

The following is a standard that has been found to answer well:—

No. 1.—*Cadmium iodide ...	... ...	4½ grains
Cadmium bromide	... ...	2 ,,
Plain collodion ...	... ...	1 ounce

On referring to the above table, the following modifications arise in the formula where alkaline salts are used:—

No. 2.—Ammonium iodide	... ...	3½ grains
Cadmium bromide	... ...	2 ,,
Plain collodion ...	... ...	1 ounce
No. 3.—Cadmium iodide ...	... ...	2¼ grains
Ammonium iodide	... ...	1⅔ ,,
Cadmium bromide	... ...	2 ,,
Plain collodion ...	... ...	1 ounce
No. 4.—Ammonium iodide	... ...	3 grains
Cadmium iodide ...	... ...	½ grain
Ammonium bromide	... ...	1⅔ grains
Plain collodion ...	... ...	1 ounce
No. 5.—Ammonium iodide	... ...	4 grains
Cadmium bromide	... ...	1¼ ,,
Plain collodion ...	.. ..	1 ounce

No. 1 should be mixed at least six months before use; it then gives a delicate image and fine detail.

No. 2 should be mixed two months before use, and answers well for landscapes.

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* Cadmium renders collodion glutinous on first iodizing. When kept, it becomes more limpid. Ammonium fits collodion for more immediate use, as it does not cause it to become glutinous, even on first iodizing.

No. 3 should be prepared four months before use, and is good for portraiture.

No. 4 may be used after mixing two or three days, and is a good "general purpose" collodion.

No. 5 is a collodion much to be recommended. It gives fair density with detail, both in the high-lights and shadows; it can be used two or three days after making.

The following general rules may be given for modifying the tendencies of collodion:—

A.—If a *decrease* of contrast and more detail be required, add bromide.

B.—If violent contrasts are wanted, the iodides should be increased and the bromides diminished. One quarter-grain of bromide to the ounce of collodion is found to be sufficient to secure cleanness in the shadows, and all but this quantity may be left out if necessary.

As before stated, for certain classes of work it may be necessary to resort to simply iodized collodion, no bromide being admissible. The following are formulæ which have been adopted:—

No. 6.—	Ammonium iodide	4 grains
	Plain collodion	1 ounce
No. 7.—	Cadmium iodide	5 grains
	Plain collodion	1 ounce

No. 6 should be iodized almost immediately before use.

No. 7 requires keeping, and is a most stable collodion.

It should here be noted that it is customary, though not necessary, to leave out half the alcohol from the plain collodion, and dissolve the iodide or bromide in the quantity thus omitted. This procedure has advantages, and may be followed if considered convenient.

Collodion should be stored in a dry and cool place to prevent the ether decomposing, which, in its turn, decomposes the pyroxyline. Collodion made with pure spirit and neutral cotton will be colourless after iodizing, but, if made with impure solvents, it will become first dark, but may afterwards return to its colourless condition. Should the pyroxyline be acid (not sufficiently washed after preparation), the collodion will become sherry-coloured almost immediately, but will not keep in good working condition for long.*

Methylated alcohol and ether are often employed by manufacturers as solvents. Experience teaches that, although apparently harmless at first, they both, particularly the former, contaminate the silver nitrate bath if used for any length of time. It is also noticeable that a collodion made with pure solvents frequently refuses to work in a bath to which methylated solvents have had excess.

Collodion should be always labelled and dated after manufacture and iodizing. This precaution will be found of the greatest use in selecting a specimen suitable for any particular purpose. The following is a specimen of a label :—

Plain Collodion made 15th July, 1884.

Pyroxyline (prepared 1st June, 1880)	6 grains
Papyroxyline	2 ,,
Sulphuric ether (pure)	½ ounce
Alcohol ·820	¼ ,,

Iodized 4th *August*, 1884.

Ammonium iodide	2½ grains
Cadmium iodide	2 ,,
Cadmium bromide	2 ,,
Alcohol ·820	¼ ounce

Any bottle of collodion thus labelled will tell its own tale, and be a guide for future manufacture. With the collodion of commerce, all you can do in labelling is to give its date of iodizing ; even this will be found very useful.

When the iodized collodion is of a pale straw colour, it is in its most sensitive condition, and this may be produced by adding a few drops of tincture of iodine. A certain amount of free iodine is almost a necessity to obtain bright pictures, for reasons which will be evident from Chapter IV. ; with methylated solvents more particularly, the colour may disappear after a time, and then more iodine must be added. After the iodized collodion spontaneously assumes the dark brown sherry colour, from

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* The contact of iodine with ether compounds is apt to form an organic compound. There is also a possible formation of aldehyde and acetic acid, the formation of which reduces silver from the nitrate solution.

the liberation of iodine,* it becomes less sensitive, and is more apt to give harsh pictures.

After plain collodion has been made, it should be allowed to stand till it is perfectly bright through the deposition of a fine sediment, when the top should be decanted or syphoned off. It should be tested before iodizing. A plate should be coated, and it should be observed if it dry with any opalescence. Next, the film should be tested to see if it be powdery, or if it come away in strips to the touch of the finger. After it is iodized, it should be tried by taking two or three negatives, the behaviour of the films being carefully noted. It is useful to have a sample of good standard collodion at hand with which to compare it. If the two halves of a stereoscopic plate be coated with the two collodions respectively, and the sensitized films be exposed simultaneously, their relative sensitiveness and densities may be readily determined, and the results should be noted for future guidance. Any defect in the collodion should, of course, be corrected.

Collodion which yields a thick creamy film gives a "plucky" image, whilst a limpid collodion gives one thin and transparent. This latter can be improved by adding a grain or two of pyroxyline to each fluid ounce. Should this defect arise from the use of alcohol which is too anhydrous, it may be rectified by the addition of a drop of water to each fluid ounce. Collodion that has been iodized a long time often has this defect.

It will be found advantageous at times to mix the collodions prepared by different formulæ; thus, a collodion yielding great intensity of image should be mixed for general purposes with one which is deficient in this quality. This remark applies not only to home-made, but also to commercially-supplied, collodions.

When testing the plain collodion, should the film dry matt, the sample must be rejected, as the pyroxyline must be unsuitable.

Should the film, after sensitizing, appear like watered silk, then the collodion is too alcoholic, or else contains too much iodide and bromide. The probable cure for this is the addition of a drachm to the ounce of plain collodion prepared according to formula 1, page 8. Should the defect arise solely from the collodion being too alcoholic, it is probable that if the film be allowed to set more thoroughly before sensitizing, a cure will be effected. When collodion is under-iodized, the developed

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* The whole of iodine must be liberated before any bromine can be found in a free state.

image will be poor and flat, though it is necessary to distinguish between this cause for the defect, and that due to impurities in the negative bath (see page 71).

If the film, on drying, show "crape markings," the plain collodion has been prepared with solvents of too great a specific gravity—*i.e.*, with too much water in their composition. To remedy this defect, an iodized collodion, formed of absolute ether and alcohol, should be added till the markings disappear.

Should the collodion, on setting, prove of a horny repellent nature, the defect may be mitigated by shaking it up with a small quantity of carbonate of soda, and decanting the supernatant liquid from the residue. A drop or two of water to the ounce will frequently answer the same purpose.

If collodion be made up with absolute alcohol and ether and the above amount of iodides and bromides, it will be found that the plate has the appearance of being stained with opaque streaks, especially at the corner of the plate from which the collodion was poured off, where, consequently, it was least set. To remedy this it is a good plan to add water to half the amount of collodion, till it appears, on the withdrawal of the plate from the bath, to have the appearance of crape, then to add the remaining half to that portion which was watered. On trying a plate, it will be found that the film has lost the streaks, and is more dense than before. The amount of water that can be added depends a good deal on the quality of the pyroxyline.

The Sensitizing Bath.—The strength of the sensitizing bath is of the utmost importance in photography, as is also the purity of its constituents. The silver salt employed is invariably the silver nitrate, as it is the form most attainable in commerce, and can generally be procured free from impurity. Silver nitrate is readily soluble in its own weight of cold water, and in a still higher degree in hot water; but for the purpose to which it is to be put in the present instance, a far weaker solution is preferable. When iodides or bromides are used in the collodion, the utmost strength admissible is 50 grains of silver nitrate to each ounce of water. For ordinary use even this proportion is too large, since silver nitrate in solution will dissolve up a certain amount of silver,* the quantity depending upon the strength of the silver solution, and on the temperature. If the solution were not, therefore,

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* It will dissolve scarcely any silver chloride or bromide, hence it is unnecessary to saturate it with these salts.

saturated with the silver iodide, on the immersion of a collodion film the silver iodide would be partially or wholly dissolved out, according to the time of immersion. Now, it is easier to saturate a dilute than a strong solution, and a variation in temperature causes a less marked difference with the former than with the latter. It is therefore evident that the less silver salt in solution, the more likely it is that the solution will not show signs of under- or over-saturation of iodide.

The acidity or alkalinity of the bath is a condition to which it is necessary to give attention, the sensitiveness of the plate being dependent in a great measure on it. When simply iodized (with no bromide) collodion is used, the solution should be strictly neutral, or very slightly acid; whilst with a bromo-iodized collodion it should be decidedly more acid, unless there be a large amount of free iodine present in the collodion. By a reference to page 3 it will be seen that the presence of the iodine will cause the liberation of the nitric acid in the film itself, and this is almost more effective than the presence of the acid in the silver nitrate solution, since the action of the nitric acid is more local.

The sensitiveness of the plate is dependent to a great extent on the purity of the water employed. Distilled water is naturally the most free from impurities, though even in it they are to be met with, unless great precautions are taken to eliminate them. When distilled water is not obtainable, water purified as given in the Appendix should be used, though if rain water, *not* obtained from the roofs of town houses (or from the roofs of country houses, unless they have been thoroughly washed previously by a heavy downfall of rain), can be procured, it may be substituted with tolerable safety.

The following formula may be used for an ordinary negative bath when bromo-iodized collodion is used:—

Re-crystallized silver nitrate ...	40 grains
Distilled water	1 ounce
Potassium iodide*	$\frac{1}{8}$ grain

Take a quarter of the quantity of water that is to be used, and dissolve the silver nitrate in it; then add the potassium

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* Some prefer not to add any iodide to the bath, but allow it to become saturated by work. If a plate be moved about continuously in a bath made *minus* the iodide, there need be no fear of pinholes. It should be stated that with a solution of greater strength than that given it is very difficult to avoid them even when adopting this method of procedure.

iodide, or other soluble iodide. It will produce an emulsion of silver iodide, which will be partially re-dissolved on agitation. Next add the remaining quantity of water, which will cause a re-emulsification of silver iodide. After filtration the bath solution should be tested for acidity or alkalinity. Blue litmus paper should redden slightly after a minute's immersion. Should the red colour be produced immediately, a little sodium carbonate should be added till a slight precipitate is produced. This should be filtered out, and the bath acidified with a few drops of a solution of nitric acid (1 drop of nitric acid to 12 drops of water). Acetic acid is sometimes recommended for acidifying the bath. If it be used, silver acetate is after a time formed, which is injurious to sensitiveness and cleanliness of work, and cannot be eliminated by any convenient method. Should the test-paper refuse to redden, the nitric acid solution should be added. As a rule, if re-crystallized silver nitrate be used, the bath will require the addition of neither alkali nor acid.

Before taking a bath solution (or *bath*, as it will be hereafter called, for brevity) into general use, it should be tested. This is best done by immersing in it a plate coated with collodion. When fully sensitized the plate should be placed in the dark slide, *half* of it exposed to white light. It should then be developed. A trace of fog on the part to which the light had no access will denote that a slight addition of nitric acid is required, or that some impurity is present in the bath. The latter case will be considered when treating of the defects in negatives.

Developers.—Acid developers may be divided into two great sub-divisions: iron and pyrogallic acid.

Pyrogallic acid developers are now rarely used, since it was discovered that ferrous sulphate was the better reducing agent. When iodized collodion is employed without a bromide in solution, pyrogallic acid may still be utilized. It gives a very dense image, and is found useful for copying purposes, though a longer exposure of the sensitive film to the action of light is required than is necessary if the ferrous sulphate be used.

A good formula for a pyrogallic acid developer for negatives and positives is as follows:—

Pyrogallic acid	1 grain
Glacial acetic acid	20 minims
Alcohol	*quant. suf.*
Water	1 ounce

Since iron developers have been introduced there have been more modifications in the formulæ used. The following ten formulæ are applicable to the production of negatives, and will be found of the greatest utility:—

No. 1.—	Ferrous sulphate	10 grains
	Glacial acetic acid	15 to 20 mns.
	Alcohol	*quant. suf.*
	Water	1 ounce
No. 2.—	Ferrous sulphate	30 grains
	Glacial acetic acid	20 minims
	Alcohol	*quant. suf.*
	Water	1 ounce
No. 3.—	Ferrous sulphate	50 grains
	Glacial acetic acid	20 minims
	Alcohol	*quant. suf.*
	Water	1 ounce
No. 4.—	Ferrous sulphate	20 grains
	Copper sulphate	10 ,,
	Glacial acetic acid	20 minims
	Alcohol	*quant. suf.*
	Water	1 ounce

The action of the different strengths of developers has already been pointed out, from which it will be gathered that in weakly-lighted views without sunshine No. 1 would be used; in moderately bright light, No. 2; and in very bright light, or where the contrasts between the bright lights and shadows are very marked, No. 3 should be used to prevent an unnatural harshness of blacks and white; No. 4 is preferred by some photographers for landscape work. It gives clean and brilliant images, and the exposure is said to be shortened.

A good ordinary developer for general use, called "Wothly's Developer," is as follows:—

A perfectly saturated solution of the ferrous sulphate in water is prepared by adding six ounces of the iron salt to a pint of water.

No. 5.—	Saturated solution of ferrous sulphate	2 ounces
	Glacial acetic acid	¼ ounce
	Alcohol	1 ounce
	Water	16 ounces

This developer keeps well, though it, like other solutions, loses its power after long mixing.

The double sulphate of iron and ammonia has been employed as a developing agent with great success. It gives great delicacy to the image, and has the property of keeping a long time in solution without change.

No. 6.—Ammonio-sulphate of iron	25 grains
Glacial acetic acid	25 minims
Water	1 ounce
Alcohol	*quant. suf.*

☞ Formic acid is not a developing agent *per se*, though at a boiling temperature it reduces the salts of silver. At a lower temperature the tendency to reduce these salts remains, hence it has been added with advantage to an iron developer.

No. 7.—Ferrous sulphate	30 grains
Glacial acetic acid	20 minims
Formic acid	10 ,,
Water	1 ounce
Alcohol	*quant. suf.*

The special qualities of this developer are, that shorter exposure is required, and detail in the shadows is brought out.

Another developer, as given by Rangel, is well worthy of notice:—

No. 8.—Ferrous sulphate	2 ounces
Water	10 ,,

Add to this, when dissolved—

Ammonia (·800)	$1\frac{1}{2}$ to $1\frac{3}{4}$ drms.

This will deposit the iron as protoxide. Add to the solution containing the precipitate—

Glacial acetic acid	2 ounces

This will re-dissolve the ferrous oxide. Two to three ounces of this to be added to one pint of water for ordinary use. It may be used of greater strength if requisite.

It will be found advantageous to dissolve the ferrous-sulphate in the water previous to the addition of the acetic acid or alcohol. As a rule, a red deposit of iron will appear; this may be filtered out after the addition of the acetic acid.

This developer works very slowly, but very evenly, and is a very useful formula for beginners.

The addition of different organic substances to the developer has been proposed by various photographers. The following are most to be recommended :—

No. 9.—	Ferrous sulphate	20 grains
	Glacial acetic acid	18 minims
	Lump sugar	10 grains
	Alcohol	*quant. suf.*
	Water	1 ounce
No. 10.—	Ferrous sulphate	20 grains
	Glacial acetic acid	10 minims
	Gelatine*	1 grain
	Alcohol	*quant. suf.*
	Water	1 ounce

In connection with developers, the collodial restrainer introduced by Mr. Carey Lea should be noticed, since it has found favour with many photographers. It is prepared by taking one ounce of French glue, and softening in one and a-half ounce of water to which one drachm of sulphuric acid is added. The water is then boiled, to dissolve the gelatinous body, and, after the addition of half an ounce more of distilled water, the boiling is continued a couple of hours. Eighty grains of granulated zinc are next added, and the boiling again continued for one and a-half hours. The solution is now allowed to settle, and the clear fluid is decanted off. To every three ounces of a fifteen-grain solution of iron, one minim of this solution is added.

The addition of these "organifiers," as they popularly are termed, has an effect on the colour of the image, owing to the silver being deposited more slowly. The use of sugar is found not to necessitate a longer exposure than if the ordinary developer be used; but the addition of the gelatine requires the action of light to be more prolonged to yield equivalent detail. Great density in a negative is yielded by all these organifiers, but generally at the expense of the half-tones. They are not, as a rule, to be recommended, excepting for winter work, for copying plans, or for producing great contrasts in a landscape.

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* The gelatine should be first swelled up by cold water. Afterwards it should be dissolved by heat, and then the acetic acid added to it.

In all cases the ferrous sulphate will, after a certain time, absorb oxygen from the atmosphere, and become ferric sulphate. As ferric sulphate will absorb no more oxygen, it is evident that its developing powers are lost, and, in fact, it is found that it acts as a retarder and even a destroyer of the image. The change in the salt of iron is shown by a red, rusty colouration of the developer. This colour may become visible, in hot weather, two or three days after the solutions are mixed; in colder weather a longer time elapses before the formation of any distinguishable ferric salt. A little ferric sulphate in the solution tends to keep the shadows in a negative bright, acting somewhat similarly to acetic acid.

In time the crystals of the ferrous sulphate slightly decompose, a yellowish powder forming on their faces. This is due to the formation of an insoluble oxide of iron. Allowance in weight should be made for this.

With a new bath containing little or no alcohol, developers may be employed without the addition of any alcohol. After the bath has been worked for some time, it gets impregnated with the collodion solvents, and then the alcohol, *quant. suf.*, must be added to cause the developer to flow without repulsion. 15 to 20 minims per ounce of water will generally be the quantity required.

Intensifiers.—The following are formulæ for "density" (see Chapter III.) intensifiers:—

No. 1.—	Pyrogallic acid	2 grains
	Citric acid	2 to 4 ,,
	Water	1 ounce
No. 2.—	Ferrous sulphate	5 grains
	Citric acid	10 ,,
	Water	1 ounce

No. 3.—An ordinary developer without alcohol.

Nos. 2 and 3 are usually employed in portraiture, and they are unusually efficacious in bringing out detail.

No. 1 brings up density more quickly than Nos. 2 and 3, and acts well for a properly-exposed picture. Any of the above may be used either before or after fixing. To each a few drops of a 10-grain solution of silver nitrate should be added immediately before it is applied to the negative.

Mr. Farmer* has worked out a method for intensifying plates with an alkaline solution of silver. The following is the description.

No. 4.—Silver nitrate	1 ounce
Water	12 ounces
Potassium bromide	¾ ounce
Water	2 ounces
Thiosulphite of soda (hypo) ...	2 ,,
Water	6 ,,

Add 2 to 1, and, after washing the precipitated bromide thoroughly by decantation, dissolve it with agitation in 3. The muddy liquid thus obtained is either filtered *perfectly clear*, or placed aside for a day, and the clear solution syphoned off; it is then made up to sixteen ounces with water, and kept for use.

Method with Pyrogallic Acid.—To intensify a plate after washing and fixing, take it on a pneumatic holder, and flood with the following mixture:—

Pyrogallic acid...	4 grains
Water	2 ounces
Silver solution	1 drachm

to which is added, immediately before use, about half a drachm of dilute (1 to 8) ammonia. It is impossible to give the exact quantity of ammonia, as it appears to vary considerably with the temperature of the solution and other slight differences. If the silver show no tendency to reduction, add more ammonia; and if it be thrown down immediately, use less; with a little experience the appearance of the liquid shows when sufficient is added. Obviously, the requisite quantity of pyrogallic acid and ammonia can be taken from the ordinary alkaline developing solutions. The plate should be gently rocked, and fresh solution poured on as the image gradually increases in density. If not sufficiently dense, and the solution be muddy, rinse the plate, and use fresh. When the required density is obtained, rinse the plate.

Method with Ferrous Oxalate.—Immerse the washed plate in the silver solution, and leave it there for five minutes; take out, drain, and flood with an ordinary oxalate developer, when the image will rapidly increase in density. Rinse the plate, and place in the fixing and clearing baths for a short time, as before.

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* The writer had shown that alkaline intensification was possible in 1874. See *Photographic News*, March 17, 1874.

If the plate only require slightly intensifying, dilute the silver solution more or less, as desired.

The next formula is for changing the metallic silver, after the image is fixed, to the state of iodide.

No. 5.—	Iodine	1 grain
	*Potassium iodide	2 grains
	Water	1 ounce

After this solution has been applied to the film, any of the following may be used to cause the formation of a non-actinic colour.

Potassium permanganate intensifier.

No. 6.—	Potassium permanganate	18 grains
	Water	1 ounce

This is most easily applied by immersing the plate in a flat dish containing the solution till the image appears of a yellowish colour throughout. The potassium permanganate is decomposed on coming in contact with the silver iodide, and parts with its oxygen, which combines with the silver; at the same time, the insoluble binoxide of manganese is precipitated on the image.

No. 7.—	Uranic sulphate or nitrate	1 drachm
	Potassium ferri-cyanide	1 ,,
	Gold ter-chloride	1 grain
	Water	20 ounces

The colour of the deposit by this intensifier is changed to a rich chocolate brown. The solution should be used in a flat dish.

No. 8—	†Mercuric di-chloride	2 grains
	Water	18 ounces

Add a solution (10 grains to 1 ounce of water) of potassium iodide till the red precipitate formed by its addition is on the point of becoming permanent.

No. 9.—	‡Mercuric chloride (corrosive sublimate)	20 grains
	Ammonium chloride	20 ,,
	Water	1 ounce

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* Iodine is very sparingly soluble in water; if potassium iodide be added, complete solution takes place.

† In this case No. 4 formula need not be used, as the potassium iodide in this plays its part.

‡ Mercuric chloride is only sparingly soluble in water; the addition of ammonium chloride causes it to dissolve readily.

With Nos. 7 and 8 the following solutions may be used, should sufficient density (as would be the case in copying plans) not be obtained. The reactions that take place when employing them have been explained in Chapter III.

Ammonium sulphide	1 ounce
Water	30 ounces

Or,

Potassium cyanide	5 grains
Water	1 ounce

Silver nitrate to be added till a permanent precipitate is obtained. This last solution should stand a night before it is used.

Or,

Ammonia	1 drachm
Water...	1 ounce

Nos. 4, 5, 6, 7, and 8 must not be applied until the image has been fixed.

An intensifier which has met with much favour is made as follows:—

No. 10.—50 grains of copper sulphate in water	1 ounce
30 grains of potassium bromide in water	1 ,,

The mixture is flowed over the fixed image till it is perfectly blanched. After thoroughly washing under a good stream of water, the image is flowed over with a 100-grain solution of silver nitrate, when an intense black will be produced. The first solution produces silver bromide and copper sub-bromide; the latter leaves the bromide unchanged; but the copper sub-bromide is converted into silver sub-bromide (see page 14).

Eder and Toth intensify with the following solution:—

No. 11.—Plumbic nitrate...	20 grains
Potassium ferricyanide...	30 ,,
Water	1 ounce

The plate is well washed, after fixing, with fairly pure water (free from sulphates), and is immersed till the image becomes opaque. It is again washed till the transparent parts are free from any deposit which may be on them, when it is treated with

Ammonium sulphide	1 part
Water	5 parts

When the sensitive film has been exposed, and developed sufficiently to bring out the details of the image, and when there is no tendency for the shadows to be "fogged" or veiled, intensification, *by increase of density*, should take place *before* fixing; if there has been over-exposure, *after* fixing. With an over-exposed picture, intensification before fixing acts as a development, and would cause fog; in most cases it is wise, before using the intensifier, after fixing, to flood the plate with No. 4.

Fixing Solutions.—The following are the formulæ usually adopted:—

No. 1.—	Sodium hyposulphite	1 ounce
	Water	6 ounces
No. 2.—	Potassium cyanide	25 grains
	Water	1 ounce

Varnishes.—Varnish is used to give protection to the delicate collodion film. It is simply a resin or resins dissolved in spirit of some description. When the solvent evaporates spontaneously, or by aid of heat, a thin layer of the resin is left, which gives the necessary toughness to the image to prevent damage in printing operations.

As a rule, it may be stated that the more colourless a varnish, the more suitable it is for negatives.

The solvent used for varnishes is usually methylated alcohol. Undiluted wood spirit is a solvent of pyroxyline; it is important that the specific gravity of the solvent should be so great that the image may not be dissolved away with the film. It should also be noted that the resin dissolved in pure alcohol of low specific gravity will dissolve pyroxyline, hence varnish should not be made with absolute alcohol.

The proportions of the constituents of most photographic varnishes are, as a rule, trade secrets, but the following answer well:—

Alcohol	16 ounces
*Unbleached lac	2 ,,
Sandarac	2 ,,
Canada balsam	1 drachm
Oil of thyme or lavender	1 ounce

The resins should be dissolved in the alcohol by means of a

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* Bleached lac absorbs moisture, and tends to make the varnish crack.

water bath. The plate should be warmed as hereafter to be described, heat aiding hard and bright drying of the varnishes.

Seed lac	1 pound
Methylated spirit	1 gallon

The seed lac is allowed to remain in contact with the solvent two or three days, shaking at intervals to aid solution. The clear liquid is then decanted off, and thinned down (if necessary) to a proper fluidity.

Amber varnish, which is applied to a cold plate, is made as follows :—

No. 1.—Amber, in fine powder	1 ounce
Chloroform	16 ounces

Or,

No. 2.—Amber	1 ounce
Benzole	16 ounces

The amber should be heated in a closed vessel to a temperature of 570° Fah., when it will begin to soften. It can then be dissolved readily by the solvents.

In some cases but a few prints may be required from a negative. As a resinous-varnished film is difficult to wash off the glass, the following may be substituted for the spirituous varnish :—

Albumen	1 part
Water	3 parts

A dilute solution of gum-arabic may be used instead. In both cases the drying of the film should take place spontaneously. If the collodion film be dry, it should be wetted previous to the application of the albumen or gum solution.

CHAPTER VIII.

MANIPULATIONS IN WET PLATE PHOTOGRAPHY.

Cleaning the Plate.—It is advisible to grind the edges of the plate previous to taking it into use. This may be effected by a corundum file supplied for the purpose by most dealers. An ordinary fine file will answer, but it is then a good precaution to moisten it with a little turpentine, to prevent fine particles of glass* from flying on to the surface of the plate. Turpentine also gives a better bite to the file. Failing these implements, the edge of one plate may be drawn against the edge of another, which will partially accomplish what is desired.

The tip of the thumb-nail should now be passed over both surfaces of the plate to ascertain which was polished in the manufacture. The unpolished surface generally feels gritty to the touch. If both surfaces feel rough, the plate should be immersed in nitric acid and water, and allowed to soak for a few hours. It should then be washed under the tap, and allowed to drain. If there be many plates to drain, they should be kept separate from one another.† A good method is to stand them on edge on the floor or table, so as to support one another, as we see children make cards support one another in building a card house. When drained, the tripoli powder solution should be applied to the plates with a tuft of cotton-wool or old rag. A

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* When subsequently cleaned they might cause scratches on the surface.

† If the water contain chalk or other soluble solid impurity, so that the edge of one, if allowed to rest against the surface of another plate, forms an opaque chalky mark on the latter, this will entail the application of acid once more.

small quantity, sufficient to form a pool the size of a sixpence, may be poured on the plate, and rubbed well over the surface. It is sometimes recommended to let this dry, but, as a rule, it is preferable to remove it whilst moist, taking care that there is no arrest of motion before the surface appears bright. A diaper duster, which has been well washed in plain water, and then dried, should be employed to rub off the cleaning solution.

A perfectly dry silk handkerchief or chamois leather should be reserved to give the final polish. (These should be well washed in sodium carbonate, or pearl-ash and water, then well rinsed, and finally dried, before use.) The motion of polishing the plate should be light, and in a circular direction. Polishing generates electricity, positive on the plate, and negative on the rubber, and electricity prevents the adhesion of the collodion film to the glass; but the electricity may be dissipated by passing the handkerchief or cloth *very* slowly over the surface. This allows the re-combination of the two electricities. Sometimes it is useful to have a plate-holder on which to clean plates. There are certain unscientific holders which the unthinking tyro purchases, with the result that in his endeavour to get a firm hold of the plate with it, he breaks his glass, and throws up plate-holders altogether in disgust. The plate-holder recommended by Mr. Paget, however, may be relied upon. It is described as follows:—

"The cleaner . . . . consists of a board covered with two thicknesses of flannel, held down by strips of wood on all sides except at C (fig 12), where there is a thumb-hole. The strips are of the same thickness as the glass, or are feathered down to that thickness at the inner edge, and enclose a space of the exact size of the glass, which is thus held firmly in its place. The strips are not under-cut. On the contrary side of the board from

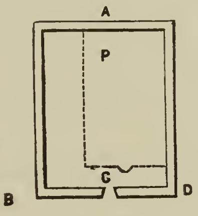


Fig. 12.

Fig. 13.

the flannel is fixed a strip of wood along the side B D, and a peg at P, both of which are shown in fig. 13, which is a section, through A C, of fig. 12. A hole is bored in the table at the distance P C from its edge, so that the cleaner is held perfectly fast by the strip and peg, without any assistance from the hand; and when a plate is placed in it, the glass is, for practical purposes, as firm as if it were glued to the table, but yet it may be removed by the thumb in a moment. When part of the table can be spared for the purpose, the flannel may be laid upon it, and the strips screwed through the flannel to the table, thus forming a fixed plate-cleaner of the very simplest possible construction."

Where different sizes of plates are used, ∟ pieces, giving the proper dimensions, may be made as shown in the diagram.

If the polishing be complete, condensed breath should leave the plate in a regular and even manner. When breathing on a plate, the mouth should be kept near its edge, and almost on a level with the upper surface, and care should be taken that no small particles of saliva fall on it. The moisture from the breath should be fully dissipated before an attempt is made to re-polish. If not, transparent patches on the plate will be visible when it is breathed on again. A golden rule to remember is, that *every plate has two surfaces to be cleaned.*

When plates are old, they will not always polish properly, however much care may be taken. In such a case a dilute solution of albumen and water may be applied with the Blanchard brush with good effect (see "Dry Plates"). The writer contends, however, that a properly cleaned plate is always safer than one so treated. This mode of preparing the surface with albumen is often caused from laziness rather than from absolute necessity.

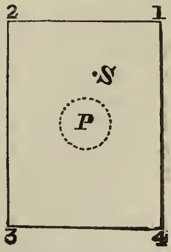
Clean plates can be well stored in absolute contact with one another, provided they are tightly packed. If loosely packed, any small particle of grit that may get between them will be liable to cause scratches on the surfaces. Another method of storage is in plate-boxes. This is not satisfactory, since all glass in contact with the air is liable to attract moisture and greasy matter. Clean blotting-paper is the best substance in which to pack clean plates.

Coating the Plates with Collodion.—It is unadvisable to coat a plate with collodion from a bottle which can contain more than five or six ounces, and a bottle of this size should only be filled up to an inch or so below the neck. A large bottle is unwieldy, and the collodion is apt to run down the sides of a completely filled bottle. Convenient pouring bottles for the dark-room have been introduced, but for out-door work the ordinary six-ounce bottles* will answer well. It is recommended that corks should replace glass stoppers: the former clean the inside of the neck of the bottle from the thick collodion, whilst the latter are apt either to stick fast, or to be forced out by the ether vapour when the weather is warm.

If practicable, the collodion from the plate should not be returned into the same bottle as that from which it was poured, as any floating dust which fell upon it whilst coating one plate would probably appear on the next. Owing to the evaporation of ether, collodion in time will become too thick for use, and must be thinned with a mixture of one part of alcohol (·805) to two parts of ether (·730).

Dust should be removed from the plate with a broad badger-hair brush before coating. The brush must be perfectly dry, and care should be taken not to generate electricity by too vigorous a motion.

In coating a plate, the use of a pneumatic plate-holder† is a great comfort; if it be used, it should occupy the centre of the plate, as shown in the figure by P. The plate should be held at first horizontally, corners 1 and 2 being away from the manipulator. The collodion should be poured on to a spot S, the mouth of the bottle being as nearly as possible in contact with the plate, in order to avoid the formation of air-bubbles. S is fixed by the fact that the wave of collodion should reach corner 1 when such a quantity is on the plate as is just sufficient (or barely more) to cover a circular patch of the width of the plate. The collodion wave should then be caused to flow to 2, next to 3, and finally the excess should be poured off at 4. The wave should be directed successively to these points by slightly tilting



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* A broad lip aids much in securing a uniform flow, and prevents the collodion running down the outside of the bottle.

† One holder should be religiously preserved for collodionizing the plate, and for no other purpose; another one should be set aside for the developing and fixing operations.

the plate. Whilst the collodion is being poured off at 4, the plate should be rather more tilted, till the excess has been drained off, after which it should be made to assume a nearly horizontal position, a slight inclination in the direction of 4, however, still being preserved. A gentle rocking motion should now be given to the plate, but there should be no grinding of the glass from the edges of the plate against the neck of the bottle, as small particles of glass might fall into the collodion, and appear as imperfections in subsequent films.

The collodion wave should not pass twice over the same spot, especially near corners 1 and 2. If it does, the almost invariable result is the thickening of the film at that place, which has the appearance of a drooping "curtain" by transmitted light. Should an air-bubble spoil the surface of the film, a second coating of collodion may be given. This will generally correct the fault.

Should no pneumatic plate-holder be at hand, the plate, if of moderate size, should be held by the thumb and middle of the first finger by corner 2, the extreme point of the corner alone being held by the cushion of the thumb. The manner of holding will enable the entire plate to be covered, and the disfiguring uncoated triangular portion at corner 2, so often seen, will be avoided.

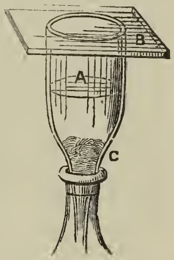
When the plate is of such dimensions as to cause the above method of holding the plate to be inconvenient, a valuable auxiliary is a bottle weighted with shot. A wooden ball covered with chamois leather has a rod inserted in it, the other end of which is fixed in the neck of the bottle. To coat a plate with its aid, one corner rests on the ball, and the opposite corner is held by the fingers, as before indicated.

When the collodion at 4 refuses to drop, and the film at 2 appears to the finger to be in a tacky state, the plate is ready for immersion in the bath. This "setting" of the film, as it is technically termed, is brought about by the partial evaporation of the ether and alcohol from the collodion.

In hot weather, one minute will generally suffice to cause setting, whilst in cold weather five or six minutes, or more, will be necessary. It is important that the right moment should be seized for immersing the plate in the bath, since defects in the film may make their appearance on development, or during sensitizing, if the collodion be insufficiently or too much set.

It has of course been supposed that the manipulator has examined his collodion to ascertain if it be free from small particles of undissolved pyroxyline or dust, also that no incrustation is on the neck of the bottle. The former will give plates which are specky in appearance, whilst the latter will speedily tell its own tale.

Collodion should, if practicable, be decanted from a larger into the smaller pouring bottle, either by means of a syphon arrangement, as usually employed in the laboratory, or by carefully pouring off the top layer of the fluid. Collodion holders are to be obtained, holding from a quart upwards, which have a glass stopcock inserted about 1½ inches from the bottom. With this arrangement the collodion can be drawn off free from sediment. It, however, frequently occurs that even decantation will not free the collodion from small floating particles. When this is the case, resort must be had to filtration. A convenient filter is to be obtained from Messrs. Powell, of Whitefriars Glass Works. A is a funnel with ground top, to which a glass plate, B, acts as a cover. Prepared cotton wool or glass wool is packed tolerably firmly at C, and is then moistened with alcohol (·820). The collodion is introduced into the funnel, and is allowed to filter through the plug into a bottle beneath.



Sensitizing the Plates.—The glass plate having been coated, the next operation is to sensitize the film by converting the soluble bromo-iodide into silver bromo-iodide. Most foreign photographers employ a horizontal tray to hold the sensitizing solution, but it is not recommended, excepting for plates of very large size, in which case it is absolutely necessary to employ this form of apparatus. The usual form of holder used for holding the solution is the vertical dipping bath, into which the plate is lowered by a dipper. The horizontal bath has the advantage of taking less solution to cover a plate, though this advantage is more than counterbalanced by the rapidity with which it becomes saturated with ether and alcohol.

The corner of the plate from which the collodion has been poured off should be allowed to remain downwards.* When

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* Some operators keep this corner upwards. This may cause a "curtain" of collodion at that part of the plate.

placed on the dipper in this position, the plate should be *gradually lowered, without stoppage,* into the dipping bath.

When once covered,* the plate may be gently moved up and down (and also horizontally, if the bath be large enough) till all repulsion of the aqueous for the alcoholic solution has disappeared. This effect of this repulsion is known by the bath solution collecting in tear drops and rivulets on the surface of the film, and is technically called "greasiness." This operation probably takes two to four minutes in cold, and only one and a-half in warm weather.

When this motion is not given to the plate in the bath, the alcohol often collects in permanent rivulets on the surface of the film, preventing the access of the sensitizing solution to the bromo-iodides beneath them. When, finally, the alcohol has become dissolved in the water, the beds of these rivulets would probably be less dense than those portions which had access at once to the bath solution, and the result would be the production of a streaky negative. By washing off the alcohol, as described, no rivulets can collect; the film must become evenly sensitized, even before the total "greasiness" has disappeared.

When the greasiness can no longer be traced, the plate should be allowed to remain at rest for another minute and a-half to three minutes, when, after a few more vertical motions in the bath, it may be taken out.

This last operation is generally performed in a hurried manner. Were more thought ordinarily exercised over every operation, many vexatious failures and much loss of time would often be avoided. A very little reflection must point out the utility of abstracting the plate *very* slowly. The capillary attraction of the liquid in the bath for the liquid on the plate will, if time be given, almost prevent the necessity of draining. The advantage of this force of nature is entirely lost by a rapid removal of the plate.

In taking the plate out of the bath-holder, the dipper holding the plate should be very slowly raised, till a corner of the glass can be seized by the fingers of the disengaged hand. The top

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* In this manipulation great care should be taken that the plate is kept entirely covered by the bath solution during the first minute, otherwise the film may become unevenly sensitized at the upper end, presenting an appearance of watered silk.

edge of the plate should be forced away from the dipper (if it be not made of silver wire), in order to prevent an acumulation of bath solution between these two surfaces, and the plate is then raised till it is clear of the solution, when it is immediately turned to the position it is to occupy in the dark-slide. When a horizontal bath is used, all the solution is tilted to one side of the dish, the plate laid flat on the uncovered portion, the solution is then made to pass over the plate with one continuous wave, and it is rocked till all greasiness has disappeared.

It will be remarked that different lengths of time for sensitizing are given below, to understand the reason of which, the nature of the sensitizer, the proportion of iodide to bromide in the collodion, the strength of the bath solution, and the temperature must be considered.

1st. With a strong bath solution a less time is required for fully sensitizing the film than with a weak one.

2nd. The greater the amount of bromide in the collodion the longer the operation will take, as the formation of silver bromide is much less rapid than that of the silver iodide; in fact, all the silver iodide has to be formed before any silver bromide is formed.

3rd. The colder the weather the longer will be the time of immersion, as cold renders the access of the bath solution to the film more difficult.

A general rule as to the length of time required for sensitizing ordinary commercial collodion is to immerse the plate three minutes in summer and six in winter.

Before work is commenced, the bath solution should be freed from any deposit there may be at the bottom of the bottle. Filtration should not be resorted to more than is absolutely necessary. When filtration is resorted to, the honey-combed side of the filter paper should be next the funnel, and it should be moistened with distilled water before the solution is run through. This may at first cause a slight emulsion of silver iodide, since this compound is less soluble in a weak solution of silver nitrate than in a strong solution, and the water in the filter paper naturally reduces the strength of the first portion of the bath. The turbid solution should be returned to the funnel, when it will filter through nearly clear. Some filter papers contain contamination which is injurious to the bath, and should be tested. (See Appendix.) Decantation of the clear liquid from the sediment should first take place, and then the remainder (containing the deposit) may be filtered if required.

Manipulations after Sensitizing the Plate and before Development.—After the plate has been slowly withdrawn from the bath, it should be carefully drained on a pad of blotting-paper (three or four thicknesses at the least should be used), the end that is to be lowest in the dark slide being pressed down on to the pad; this prevents an accumulation of bath solution at the edge, and its consequent liability to cause stains.

The dark slide should be opened at the back, and held nearly vertical, and the plate put upon the silver wires (see Appendix) after the drainings from former plates have been removed by blotting-paper. This vertical position is one which in practice is often neglected, but is of great importance, since any silver solution which may have collected, notwithstanding proper draining of the plate, is thus prevented from running over the surface, and causing markings.

The back of the plate should then be carefully wiped with a pledget of blotting-paper or rag, to remove any silver nitrate solution which may have collected on the back. Should this precaution be neglected, horse-shoe markings (see "Defects in Wet Plate Negatives") on the developed image may be expected if the film be translucent.

Should the exposure be of considerable duration, or if the time between placing the plate in the dark slide and development be likely to be long, a moistened sheet of blotting-paper should be placed at the back of the plate. This will keep the film moist through the evaporation of the water, and if the blotting-paper be red, in a measure, it will prevent halation or blurring of the image.

Finally, a strip of blotting-paper should be placed at the lower edge of the plate, and just in contact with the film, in order to prevent any accumulation of the bath solution during exposure. The practice of letting the blotting-paper come between the film and the silver wires which hold the plate in position is to be condemned, since the inner surface of the silver wires is made to coincide accurately with the surface of the ground glass; hence if the film do not touch them, the focus of the picture is altered, which may be of consequence with a short focus lens.

The slide should then be closed, wrapped round with a cloth, and carried carefully in the same relative position as regards top as it will occupy in the camera during exposure.

The view should, of course, have been previously focussed on the ground glass of the camera. A few hints on the method of focussing may not be amiss.

The point of view having been chosen, and the camera placed approximately in position, the operator will endeavour to cause every object in the field of view to be sharply defined on the focussing-screen. He will guess which diaphragm (technically termed a stop) to use, and having inserted in it the lens, will proceed to get his final focus.

Should an architectural subject be the subject of the picture, it will be necessary that the perpendicular lines should be strictly parallel. As a rule, if it be a near view, the camera will have to be tilted in order to bring in the whole of the subject; but before doing so, the front board of the camera which carries the lens should be raised to its full extent (*i.e.*, as far as the slot which secures the screw will allow). This will raise the image from the bottom of the ground glass, and reduce the tilt necessary to be given. When sufficiently tilted, the surface of the ground glass must be brought perpendicular to the horizonal plane—that is, it should be plumb. If it be at an angle to the perpendicular, vertical lines which should be parallel in the picture will converge. It may here be remarked that the ordinary single lens will always show as curves what in the view are straight lines, when they lie towards the margin of a plate; hence architectural subjects should, as a rule, be taken with a doublet, or any non-distorting lens. A spot, about one-third way from the centre of the picture, towards the edge should be selected, and that brought into sharp focus. If the diaphragm used be small enough, this will generally secure an equable focus throughout the picture; other points should then be selected and tried for focus; and that point which makes the focus generally sharpest should be selected as final. It should be noted that *the* object of interest should be especially sharp; a slight lack of definition in other portions being sometimes an improvement, as causing the eye to wander less from the spot on which it was intended to rest.

Should it be a landscape that is to be photographed, the swing-back need not be kept in a vertical position, as the perspective will not obviously suffer. In fact, it often happens that a large diaphragm may be employed, by judiciously using the swing-back to bring the foreground and distance into focus together, for the nearer the object the longer will be the focus, and *vice-versa*. Hence by pulling out the top of the swing-back the length of the focus is obtained, instead of by the employment of a small diaphragm.

Care should be taken that the screws fixing the camera to the legs are tight, and that the latter have a firm grip on the ground. Where the ground is soft this is especially to be watched.

The object to be photographed having been properly focussed, the cap is replaced on the lens, and the slide gently placed in the camera. The front of the slide is next pulled out, and the exposure commenced. (It is often advisable to place the focussing-cloth round the camera and over the dark slide, to prevent any possible access of light to the plate, except through the lens.) The grand rule for timing the exposure may be stated to be—"*Expose fully for the details in the deepest shadows; the high-lights will take care of themselves.*" In bright spring weather, with white fleecy clouds, and a fairly open landscape, three seconds' exposure with a Dallmeyer's rapid rectilinear lens, and the 3-stop for 8½ by 6½ plates, should suffice. For calculating exposure with other lenses, see Appendix. During the time of exposure never touch the camera or legs with the hand; it should be remembered that the human body vibrates, and that these vibrations will be communicated to the camera.

Should the picture happen to be taken outside the studio in windy weather, lulls must be watched for, and the cap cautiously replaced on the lens during the gusts. A heavy stone suspended by a string from the top of the camera-stand will often check oscillation during exposure.

The same precautions in carrying the dark slide to the developing room or dark tent should be observed as those already given for carrying it to the camera.

Development.—Having filtered the developer,* if requisite, and placed the necessary quantity in the clean developing cup, the plate should be taken out of the slides, and kept inclined in the same direction as that in which it has been carried from the camera, though the angle of inclination may be much modified. The *developer is then with an even motion and without stoppage* (the rim of the cup almost touching the film) swept over the

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* For the developer to be used, a reference should be made to Chapter VII.

plate till the latter is completely covered. As little of the solution as possible should be allowed to flow over the edges.*

The writer prefers to keep the long edge of the plate next to him, whilst the corner of the plate where any drainings may have accumulated is away from him. The plate is held with a *small* inclination downwards away from the body, and then the developer is applied as above.

The developer is worked round and round to each corner of the plate in succession till the image is fully out, which, if properly exposed, will take some minutes to effect. The deepest shadows alone should remain of the yellow tint due to the unaltered silver iodide and bromide. An under-exposed picture will take longer to bring out, whilst one over-exposed will flash out at once, and, unless the developer be immediately washed off, will appear to fade away and give a flat and fogged negative.

A properly-exposed and developed picture should, by reflected light ("looking down on the plate"), appear as a well-defined and graduated image lying on a ground of silver bromo-iodide; whilst by transmitted light ("looking through the plate"), every detail should be visible both in shadow and high-light. With proper exposure the developer may remain on the film for a long time without injury to the image.

A plate-holder† is recommended for holding the plate during development. If not at hand, the corner must be held as described in the article on "Coating the Plate" (page 58); or else the plate may be supported in the centre by the tips of the fingers, though this is not recommended, as the warmth of the fingers, communicating itself to the glass, is apt to cause uneven development at those places. In developing large plates without the aid of a plate-holder, a support similar to that described at page 58 may be employed.

Some skilful photographers develop their pictures in a tray (see Appendix) slightly larger than the plate. The plate is carefully placed at the bottom, and the developer allowed to

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* If the developer flow over the edges of the plate, it carries much of the free silver with it, which is necessary to give density to the image. Some writers advocate the loss of this free silver. I cannot advocate it from theory or experience, excepting where too much vigour in the resulting picture is feared.

† Not that one which has been employed for holding the plate during coating collodion.

flow over it in one unbroken wave. The development of the image is watched through the bottom of the dish if it be of glass.

The following maxims are worthy of attention :—

1st.—Always have a weak and a strong developer in the field and in the dark-room.

2nd.—Think well as to which will answer your purpose the better, remembering that with a strong developer contrasts of light and shade are subdued, while with a weak one they are increased.

3rd.—Use your developer before it attains the dark reddish-brown colour, and do not use methylated in place of pure spirits of wine.

4th.—The less acetic acid used, the more harmonious will be the resulting picture.

5th.—Reject a negative which is either under-exposed or much over-exposed.*

Intensification.—Practice alone can give the operator a knowledge of the exact amount of density required in a negative. Pictures are often spoilt by bringing up the half-tones to a density nearly equal to that of the highest lights. It should be recollected that the printing power of a negative not only depends upon the quantity of deposited silver, but also upon its *colour*. If a negative, on account of its density and *colour of deposit*, allow the *deepest shadows* to print to a depth verging on bronzing, and at the same time leave the *highest lights* white, or very nearly so, any further intensification will be detrimental.

The operator's judgment must decide whether he should use those intensifiers which cause increased deposit, or those which merely cause change of colour. The latter are best avoided except under exceptional circumstances, or where an engraving or similar subject is being copied.

Should the former be decided upon, and if the picture has been slightly over-exposed, it is well to stop all further danger of development by treating it with a weak solution of potassium iodide and bromide for a minute or two. This will completely check all further action excepting that of intensification. A

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* It is too often the case that time is wasted in attempting to patch up a worthless negative. If the image appear unsatisfactory, and it be possible to expose another plate, obey Rule 5.

more common method of treatment is to fix the picture first, and intensify afterwards.

Intensification before fixing should be conducted as laid down for development. The intensifier should first be flowed over the plate, next the silver nitrate dropped into the cup, and then the intensifier from off the plate poured back. By this means a perfect mixture of the two is obtained. The intensification should proceed till the requisite density is arrived at, or till the solution becomes turbid if it be of iron, or deep brown if of pyrogallic acid. In the latter cases a fresh portion should be taken, and the intensification proceeded with till complete.

When intensifying with pyrogallic acid it will be found advantageous (*should the exhausted solution not be turbid*) to leave a little brown solution in the cup, and then to add a fresh portion to it. A more even and satisfactory action seems to be set up by this artifice.

In landscapes and in portraits the highest points of light alone should appear opaque before fixing.

If it be necessary to obtain more photographic opacity after fixing, it is advisable to use the iodine solution first (No. 5, page 50).* This tends to prevent a red deposit forming on the shadows when the iron or pyrogallic acid formulæ are used. Intensification after fixing may be conducted in diffused light. It is more difficult to decide on the printing qualities of a negative which is intensified by change of colour. Practice alone can enable the operator to be sure that he has obtained the necessary opacity to the actinic ray.

Fixing the Negative.—For sodium hyposulphite, a dipping bath or shallow flat dish may conveniently be used, or the solution may be flowed over the plate; if potassium cyanide be used, the latter mode of applying the fixing agent is advisable, and care should be taken to wash the plate directly all the silver iodide and bromide is dissolved away. The absence of these salts may be known by reversing the plate, and noting if the yellow semi-opaque colour has totally disappeared from the shadows.

After *development*, *intensification*, and *fixing*, the plate should be *well washed.*

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* If the negative has dried before it is intensified, the edges should be varnished with Bates' Black Varnish, or run round with india-rubber solution, to prevent the film leaving the plate.

Drying and Varnishing the Negative.—The plate may be allowed to dry either entirely spontaneously, or else by the application of heat. Quick drying, as before stated, gives an increased density to the image; if, then, part of a negative be allowed to dry spontaneously, and part by the aid of heat, the negative will not retain its proper relative gradation.

A neat appearance is given a negative when dry, and before varnishing, by scraping off the film round each end of the plate to a distance of about one-eighth of an inch. This also prevents damp penetrating between the film and the glass plate, as the varnish coats both the margin and the film. Some photographers, after varnishing, run a line of Brunswick black one-eighth of an inch wide along the edge of the plate; this gives a white margin to the prints, and gives them a neat appearance.

Before applying spirit varnish (see page 52), the plate should be warmed.* The varnish should be poured over the film like collodion over a plate, the same gentle rocking motion being given it whilst the excess is draining off. Any varnish collected at the lower edges may be removed by pressing them down on a pad of blotting-paper, after which the plate should be thoroughly heated. When cold it is ready for the printing operations.

A good source of heat is a moderator or paraffin lamp, the plate being moved briskly over the top of the chimney; another is an ordinary fire, or a Bunsen burner with a rose; and the worst, the flame of a spirit lamp. In using this last, great care is requisite to prevent the flame setting fire to the solvent of the varnish.

It sometimes happens that the film tends to peel off and split whilst drying. The application of stale beer to the negative will prevent this fault. A weak solution of gum has been recommended, but gum has the property of absorbing moisture; it swells, and causes the film to crack, the varnish being unyielding. Gnm should, therefore, not be used, unless the negative is required to last but for a short time. The white of one egg mixed with ten ounces of water is recommended as being the safest material to employ.

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* The soft part of the back of the hand, between thumb and first finger, should just be able to bear the heat of the plate. Amber varnish is applied cold.

CHAPTER IX.

DEFECTS IN WET PLATE NEGATIVES, ETC.

In the foregoing chapter the bare manipulations necessary for taking a wet-plate negative have been discussed, and very little notice has been taken of the defects that are likely to be met with in the various stages of operating. This chapter will be devoted chiefly to a narrative of the defects, and the remedies to be applied.

Defects caused by the Glass Plates.—If the negative, after development, appears to be fogged in certain places, while the remaining portions are bright, a dirty (*i.e.*, not chemically clean) plate may be suspected. If patches of the film are wanting in optical contact with the plate, as shown by the appearance of the same when looking at the reverse surface of the film, the suspicion is confirmed.* The dirt may arise from improper cleaning of the plate with the tripoli powder or whitening (see page 35), or else from compounds unattacked by these detergents, such as the remains of corrosive sublimate (mercuric chloride) used in the intensification of a previous negative on the same plate.

The remedy, in the first case, is apparent; in the last case the plate should be washed well with water, and then steeped in nitric acid and hot water (one ounce to the quart is sufficient), and allowed to soak for twenty-four hours. This will probably cure the evil, after the plate has been thoroughly rinsed with cold water, and cleaned in the ordinary manner. Sulphuric acid

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* An iridescent film should always be looked on with suspicion. They frequently split on drying, and are not in optical contact with the glass.

and potassium bichromate, or a solution of cyanide, have been recommended. Practically they do not appear to have any advantage over the nitric acid. Should this treatment fail, the plate may be coated with a solution of albumen, as described hereafter.

Circular and straight transparent markings are sometimes met with when a negative has been taken on a plate that has been put away as clean. Their occurrence leads to the suspicion that the plate has since become damp, or that a damp silk handkerchief or chamois leather has been used in polishing, or, perhaps, that one has been used which has been washed with soap, and has not been thoroughly rinsed afterwards.

Sometimes the collodion sets in streaks from one corner or edge, forming large ridges and furrows on the plate, which become only too apparent on sensitizing. Chips in the edges of the plates will cause this defect. The collodion clings to inequalities, and by molecular attraction small pools are formed, which finally run over on the plate, and cause ridges. The remedy for this defect is to re-grind the edges of plate carefully, or, if only one edge be defective, to pour off the collodion towards that edge.

Opaque streaks in a negative are usually due to scratches in the surface of the plate. There is no cure for this defect—the plate must be rejected. If round transparent markings of the size of a pin's head be apparent in the negative, when the glasses employed are new, a crystalline deposit on the surface of the plate must be looked for.

Defects Caused by the Collodion.—When the plate is taken out of the bath, should the film appear much less opaque at the end at which the collodion was poured on than at the lower end*—1st, either the collodion has been allowed to set too long; 2nd, it has been prepared with too highly-rectified solvents, and ether in excess; or, 3rd, there is alcohol in excess, causing the plate to dry at the top before it has set at the bottom.

The remedies for the first cause are apparent; for the second, the bottle of collodion may be left unstoppered till the necessary amount of ether has evaporated, making up the quantity with alcohol, and then adding one or two drops of water to the ounce; for the third, the addition of a drachm of ether and a quarter of

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* The portion of the image developed on these semi-transparent parts would be very feeble.

a grain of iodide of cadmium to the ounce of collodion will prove effectual.

The sensitized film may show opaque markings at the corner whence the collodion was poured off. This is called "bursting out" of the silver iodide and bromide, the reason of its occurrence being that the film is not porous enough to hold them in the film. This "bursting out" may therefore be caused by too much iodide and bromide in the collodion, in which case plain collodion should be added; or it may be caused by the collodion being too alcoholic. If the film be allowed to set well before immersion in the bath, it is probable that the fault due to the last cause will be corrected.

Should the defect noticed in the last paragraph be exaggerated, shown by the iodide almost completely leaving the film in places, the collodion is either not sufficiently porous, or else has been too highly iodized. In the former case water may be added little by little, and in the latter plain collodion.

A film sometimes refuses to "work," though it may appear dense and creamy. The finger should be rubbed lightly along one corner of it, and if the silver bromo-iodide rub off, both the above remedies may be applied, since it is evident the salt is only surface formed.

When a portion of the film leaves the plate with the bromo-iodide, it has not been allowed to set sufficiently before immersion in the bath; the water in the bath acts on the pyroxyline before it becomes gelatinous (from the evaporation of the ether and part of the alcohol), and the cotton is precipitated.

Curtains on the film have been noticed in "Coating the Plate" (page 58), and the reason there given of their existence. The cure was also suggested.

Markings in the film having the appearance of a fine network or crape arise from the use of too gelatinous a sample of collodion, or from a strong cadmium* bromo-iodizer. The remedy, in the former case (in which the plain collodion *per se* gives this structure), is to add a more limpid sample to it. If caused alone by the latter, keeping will probably rectify the evil; whilst if the result be from both causes, the addition of a limpid collodion iodized with an iodide of an alkali, such as ammonium iodide, is recommended.

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* Solvents too largely diluted with water may also cause this defect.

Should the developed image appear weak, and the film be opalescent, it is probable, if the collodion be in fault, that it is deficient in pyroxyline, either from sufficient not having been employed at first, or from a deterioration due to age.

A lack of half-tones in the image may be due to the use of a collodion whose pyroxyline has been made at too high a temperature, or by the iodine in it being liberated to excess, as shown by the deep colour it assumes. The defect suggests the cure.

Should the film split on drying, it is probable that the collodion used contained too much ether. Pyroxyline made with too strong acids will also cause the evil. Mixing with another sample of collodion will probably be the best cure. If the pyroxyline be made in weak acids, the film will generally adhere to the plate; but if it be of a gelatinous kind, it may leave it.

An under-iodized collodion will cause the developed image to appear flat and lacking in density. Try adding an extra grain of iodide of cadmium to the ounce. If the collodion be too highly bromized, and remain in the bath but a short time, the same defect will occur.

Opaque comet-like spots are sometimes to be met with in the developed picture. They usually arise from dust in the collodion, due to small particles of undissolved pyroxyline. The best remedy is to have a stock-bottle for the collodion, and allow it to stand perfectly quiet. The upper portion may then be syphoned off and filtered (page 41).

Defects caused by the Sensitizing Bath.—A line across a plate, seen after sensitizing, denotes a stoppage in the motion of immersion.

Lines in the direction of the dip are generally caused by the bath being too alcoholic. (Each time a plate is immersed the water absorbs a percentage of ether and alcohol.) The excess may be removed by raising the temperature of the solution to about 200° for half-an-hour to an hour. Most of the alcohol is driven off in vapour at that temperature, whilst the aqueous solution remains behind. The solution may also be boiled down to half its original bulk, and be made up to the proper strength by the addition of purified water. These lines may also occur through the use of collodion which gives a very repellent film. This may be remedied by shaking it up with sodium carbonate, and decanting from the residue, or by adding to it one or two drops of water. Too great a quantity of alcohol in the bath, as is the case when many plates have been dipped in it, will also give a repellent film.

A scum on the film may be caused by the use of the bath containing too much silver nitrate. Test the strength of the bath solution, and add water, if requisite, filtering out any iodide that may be precipitated. A scum may also be due to the use of a collodion too highly bromo-iodized; if this be the case, the latter should be mixed with a small quantity of plain collodion. Silver acetate is likewise a cause of scum, which often may be seen floating on the surface of the solution. It should in all cases be filtered out, or be removed by drawing a strip of clean blotting-paper along the surface of the bath solution.

A bath carefully used will rarely get out of order. Sometimes, however, by accident, it may become contaminated by foreign matter, and then the negatives will be poor, flat, or, in some cases, useless, through fog on the shadows. To render the bath fit for work, resort should be had to the action of sunlight on it; after neutralizing the acid with sodium carbonate or freshly-precipitated silver oxide, sufficient carbonate is added to give a slight precipitate, or silver oxide is added (see Appendix as to its production), till some remains undissolved. The bath is then placed in full sunlight, when all organic matter will be decomposed, and metallic silver deposited by it. This is the best and, probably, the only legitimate cure for a bath that gives negatives of the foregoing description, except evaporating the solution to dryness, and fusing the silver nitrate. The addition of potassium permanganate has also been recommended. It is at the best a doubtful cure.*

Should these means fail, the best plan to adopt is to precipitate the silver, and make a new bath from it, as given in the Appendix.

There may be another cause of flatness in a negative, viz., the bath being below its proper strength in silver nitrate.†

Transparent pinholes on a negative, after fixing, are caused either by dust, or through the bath being over or under-iodized. Should they be caused by the bath being over-iodized, a granular

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* Permanganate, fifteen grains; water, one ounce. This solution to be added to the bath till a faint permanent pink colour is given.

† A method of testing the strength of the bath is given in the Appendix.

appearance will be visible on the surface of the plate by reflected light. The granules of silver iodide* separated from the bath. The remedy for this is to take one-fourth of the bath solution and dilute it with three times its bulk of water. This will cause an emulsion of iodide, which can be filtered out. The solution can then be made of proper strength, either by boiling down, or by the addition of fresh crystals of silver nitrate. Another method is to add a few drops of hydrochloric (muriatic) acid to the solution with constant agitation. This carries down the excess of iodide along with the chloride, but leaves the bath acid, from liberation of nitric acid. The addition of barium nitrate has also been recommended as a permanent cure for over-iodizing. In the experience of many operators it answers admirably. It has one defect, however, which is, that ferrous sulphate precipitates the barium as insoluble sulphate, which gives a slight veil over the image; but varnishing in a great measure restores the transparency. The following solution is recommended:—

Bath solution	1 ounce
Barium nitrate	5 to 10 grains

If necessary, the bath should be filtered after the addition of the barium salt is made. If the plate, after fixing, show signs of pin-holes, without the excrescences being previously visible, the bath is under-iodized. In this case more potassium iodide should be added.

Markings showing unequal density at its lower end may arise from the plate not being properly drained; or, if properly drained, from the dark slide being reversed from its proper position whilst carrying it.

Fog may be caused by the bath. A separate article will be given on this defect, its causes and cure.

When the bath is very acid, hard negatives, wanting in detail, often result. The acidity may arise from the use of collodion which has liberated iodine, and acidified the bath solution.† This may be remedied by adding an alkaline solution to

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* This is rather a debatable point. Some attribute them to silver sulphate, oxalate, or iodo-nitrate. The writer prefers leaving the paragraph as originally given.

† The iodine liberated combines with the nitrate of silver to form iodide of silver, and liberates, together with other products, nitric acid.

the bath. Hardness may also be due to the development (see page 49).

Transparent flashes and curtains are generally caused by the free silver nitrate drying on portions of the plate, owing to the length of time elapsing between taking the plate out of the bath and developing it. Negatives are particularly liable to this defect if the baths be at all old and alcoholic. Careful draining, placing damp blotting-paper at the back of the plate in the slide, and other obvious precautions should be taken.

Opaque makings, taking the form of lines, may occur through the bath solution collecting and running down the plate, particularly if the plate be not fully sensitized. The rivulets of bath solution complete the sensitizing of the plates in those portions alone, hence the image is stronger at those parts. The remedy is obvious.

Horseshoe markings, of about the size of a small pearl button, may occasionally be met with when a collodion is used which appears opalescent after sensitizing. They arise from the reflections from the small drops of bath solution that accumulate on the *back* of the plate. It is needless to enter into the exact cause of the horseshoe form; but it can be rigorously demonstrated as resulting from the shape and motion of the drops. By carefully wiping the back of the plate before placing it in the slide this trouble will cease.

Defects caused by Development.—Lines may occur on the negative by the stoppage of the developer when poured over the exposed plate. The stoppage is generally the result of carelessness, but it sometimes may be due to drying of the film after removal from the bath, in which case more than ordinary of the developer must be taken to enable the plate to be properly flooded. The free silver nitrate having partially dried on the film, but little will be carried away by the developer. The defect may also arise from the repulsion between the free silver nitrate on the film and the developer, either through excess or defect of alcohol.

Lines may also be caused by leaving a small quantity of water in the developing cup, which will not readily mix with the alcoholic developer, thus causing development to be delayed on those portions of the negative with which it happens to come in contact.

A poor and flat image may arise from washing off the free silver nitrate from the plate by the developer; from the use of too strong a developer; from the bath or collodion as explained in the two previous articles; or from over-exposure.

In addition to negatives becoming hard from faults in the collodion or bath, they may have the same defect from being developed with a weak developer, from one with too much acid in it, or from under-exposure. The first two causes may arise from the ferrous sulphate having changed to the ferric state, as explained at page 49.

A scum forming on the developer during development may denote a want of acetic acid in the developer.

Defects caused by Intensifying and Fixing.—The chief defects that arise through intensifying are those which may also occur in development. Fog and a red deposit on the shadows are chiefly to be anticipated. The former may occur before fixing if the pictures be over-exposed; the latter, both before and after fixing, by the addition of too much free nitrate of silver to the intensifier; or again, after fixing, by the imperfect washing of the film before the intensifier is applied. The red stain will generally yield to

Glacial acetic acid	1 ounce
Water	1 ,,

Fog may be reduced as given in the next chapter.

It should be noted that the larger the amount of silver added the more rapid will be the intensification; but the half-tones will not be brought up proportionately to the high-lights. The smaller the quantity of silver used, the greater will be the comparative force given to them, and the longer time it will take to get proper printing density. Thus, a negative lacking in contrast may be corrected by using an intensifier with large, and one too rich in contrast with small, doses of silver.

Defects caused by Fixing are few in number; the chief is that caused by the potassium cyanide eating away the half-tones, through the washing being too long delayed. If strong cyanide be used, and it be allowed to stop in its flow over the plate, a line of weak density may become apparent. A film splitting after varnishing may often be traced to the use of sodium hyposulphite as a fixing agent, followed by an imperfect washing.

Defects caused by Varnishing.—Several defects may arise in varnishing. First, the most serious, the collodion film may dissolve away. This is caused by the solvent used in the varnish being impure and of a low specific gravity. The addition of a small quantity of water may effect a cure, or varnishing the plate cold, and *then* heating it, may answer in some cases.

Should a transparent mark show across a negative immediately after varnishing, it is probable that the solvents are *slightly* too strong, and that the varnish has not been allowed to flow over the film without stoppage. The cure suggests itself.

Ridges in the varnish on the film *may* denote that too much of the solvent has been allowed to evaporate by repeated applications to others plates; in which case add more spirits of wine (·830 methylated will answer). Ridges may also arise through rough edges of the plate, or from dust on the film. Varnish may crack through swelling after it has been applied to the film, and give blisters; or it may do so through the use of bleached lac.

If from any cause it should be desired to remove the varnish from a film, it should be subjected to the vapour of alcohol; or weak alcohol may be flowed over the plate five or six times, warming the plate as if for varnishing between each application. A solution of caustic potash will also be effectual, and leave the image in its original state, after which it may be re-varnished. Varnish may also contract; this is probably through the use of copal in its composition. Should the varnish dry matt, it is probable that sufficient heat has not been applied after coating the film with it. If it dry matt in parts, it is probable that the preliminary heating of the negative has been unequal.

Other small defects may sometimes be noticed. A little thought will generally trace their cause, and suggest the remedies.

Defects caused by the Dark Slide.—Should it happen that at one or more corners of the plate the silver is reduced on development, so as to cause opaque marks, the slide should be examined. The evil may arise through the wires which support the plate not being made of *pure* silver. A coating of varnish applied to them will prevent future mischief.

Opaque streaks seen after development, running from a corner, may denote the ingress of light into the slide, or they may be due to the fingers touching the film during development.

Transparent marks of the size and shape of a pin's head, with a very small opaque dot in their centres, may show that dust has fallen from the front of the dark slide on to the film. The inside of the slide should be carefully wiped out with a damp cloth. Similar spots may arise from the use of collodion made with a pyroxyline which has been prepared with dilute acids (see page 31), though in this case the central dots are generally not visible.

CHAPTER X.

FOG ON WET PLATE NEGATIVES.

Fog or veil over a negative being one of the commonest defects met with, it may be useful to point out the method to be adopted to detect its origin.

Over-exposure in the camera is one of the most common of its causes, particularly when working with newly-iodized collodion.

The contamination of the silver nitrate bath with organic or foreign matter may also give rise to it. It is easy to account for foreign matter in the bath, the dust and other impurities that float in the atmosphere of the dark-room being one source. Distilled water may also contain it, as ordinary stills are frequently used for distillation other than that of water. A bath made of impure gutta-percha* may also account for its presence, as will the wooden case of a glass bath, if the bath solution happens to touch the wood whilst being poured in or out. In all these cases sunning the bath solution, or evaporating it down to dryness, are the most effectual remedies. Potassium permanganate may be employed as a corrective, but, as before stated, is not recommended.

Alkalinity of the bath by silver oxide, which is slightly soluble in water, will be certain to cause fog. The cure in both cases has been given, under the head of the "Sensitizing Bath" (page 44).

Diffused light in the dark-room, in the camera, or a dirty lens, will cause a foggy picture.

Vapour of ammonia, the products of the combustion of coal-gas,

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* Gutta-percha is often adulterated with magnesium salts, &c.

and sulphuretted hydrogen, are also inducive of fog. All these vapours may be detected by their smell.

The omission of the acetic acid in the developer (or the presence of too small a proportion) will cause the evil, as also a very high temperature in the dark-room. Many common sorts of filter paper contain iron, and other impurities, which may induce fog.

Tracing the Cause of Fog.—Should a negative appear fogged, another plate should be sensitized, and reduced exposure given it; if this fail to effect a mitigation of the evil, the bath should be tested for acidity or alkalinity, as shown at page 44. If the bath be of the right acidity, a plate should be sensitized and kept for two or three minutes in the dark-room. It should then be developed, and the presence of fog will indicate (supposing no hurtful vapours be present) either organic matter in the bath, or diffused light in the dark-room. Another plate, similarly treated in a really dark room, will show if it be due to the latter cause. If, however, it be proved that there is no filtration of light which can act on the silver bromo-iodide into the dark-room, another plate should be sensitized and placed in the camera. The front of the slides should be withdrawn as usual, but the cap of the lens should not be removed. The plate should next be flowed with the developer in an absolutely dark room. If fog be still apparent, the bath is at fault. If the bath be new, it may be that there are vapours present which cause fog, or it may be due to alkalinity.

If neither the bath nor the atmosphere be at fault, and if fog be present, diffused light is admitted into the camera; if absent, it is probable that the fogged negative was due to the bad lighting of the subject, or to diffused light through the lens, as in the case in which the sun is allowed to shine directly on it, rendering the glasses slightly luminous.

To render a slightly-fogged negative fit for printing, a solution of iodine and potassium iodide (page 49, No. 5) may be applied to the film, and the silver iodide dissolved way with potassium cyanide. With one or more applications of the iodic solution the veil may often be removed without injuring the density of the negative. Another method of reduction is by using the following in lieu of the iodic solution:—

Saturated solution of ferric chloride...	1 drachm
Water	1 ounce

This is floated over the negative, and, after washing, the cyanide is applied. By this method the deposit on the shadows seems to be more attacked than that on the lights; it is consequently to be preferred.

$$\overset{\text{Ferric Chloride in Solution}}{Fe_2Cl_2} + \overset{\text{Silver in the Film}}{2Ag} \overset{\text{form}}{=} \overset{\text{Silver Chloride in the Film}}{2AgCl^*} + \overset{\text{Ferrous Chloride in Solution}}{2FeCl_2^*}$$

The silver chloride is dissolved away by the fixing agent. Very dilute nitric acid may also be applied to the film, but this requires very delicate handling. The strong acid should be diluted with ten times its bulk of water.

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* It seems as if subchloride was also partially formed by the ferric chloride. The general equation, however, holds good.

CHAPTER XI.

POSITIVE PICTURES BY THE WET PROCESS.

WITH positive pictures the great desideratum is to obtain as white a deposit of silver as possible, so that sufficient contrast between the black or dark backing may be obtained. The bath itself is not required to be so strong, but the collodion may be the same as that employed for negative work.

The formula for the sensitizing bath is—

Re-crystallized silver nitrate... ...	300 grains
Nitric acid	$\frac{1}{4}$ min.
Water...	10 ounces

The bath is prepared precisely as given for the negative bath at page 43.

The following developers are efficient; the pyrogallic acid developer (on page 45), and

Ferrous nitrate	110 grains
Ferrous sulphate	60 ,,
Nitric acid	20 minims
Alcohol...	*quant. suf.*
Water...	4 ounces.

The ferrous nitrate may be prepared by taking barium nitrate 130·5 grains, dissolving it in two ounces of water, and adding to it a solution of 76 grains of ferrous sulphate in 2 ounces of water. A precipitate of barium sulphate falls, which must be filtered out, and 110 grains of ferrous nitrate are left in solution. The nitric acid should be dropped carefully in, the 20 minims being previously diluted with half an ounce of water. The alcohol is then added, *after* the 60 grains of sulphate of iron have been dissolved.

The nitric acid causes the silver to deposit with a white lustre by reflected light, and this developer is consequently very effective for the purpose required. The image should be fixed with the ordinary cyanide fixing solution given at page 52.

When the picture is taken on a ferrotype plate, nothing remains but to varnish it with ordinary colourless varnish; but it must be recollected that, in this case, the image is reversed.

When a glass plate is employed, the film side may be varnished with Bates's Black Varnish, in which case the image will appear in the natural position of the object.

A good black varnish is made as follows :—

Asphaltum	4 ounces
India-rubber solution, as supplied for telegraphic purposes	1 fluid ounce
Benzole	12 ounces

The manipulations in positive pictures are similar to those for negatives, and need not be described again. Ferrotype plates (which are thin iron plates enamelled or japanned with a chocolate brown medium) are cleaned with a little *dilute* potash, followed after with dilute nitric acid, and a final wash in distilled water. They are then allowed to dry, and rubbed over with a chamois leather or silk handkerchief, if requisite.

CHAPTER XII.

SPECIAL APPLICATIONS OF THE WET PROCESS.

Rapid Exposure.—For very rapid exposures, which are long compared with rapid exposures with a gelatine plate, some precautions must be taken.

The plates must be excessively clean, as the shortness of the exposure and the strength of the developer used render the slightest chemical dirt apparent.

A collodion containing a large amount of bromide is generally used, and it should be of a straw colour to give the best results. The addition of 1 to 1½ grains of bromide to the ounce of ordinary bromo-iodized collodion is advisable as a rule. It is recommended that the different samples of iodized collodion in stock should be tested one against the other, by means of the cut stereoscopic plate (as described at page 41), and the most rapid and delicate selected.

A newly-prepared bath (or nearly so) is an essential; the 40-grain (as described at page 43) will answer; a 50-grain bath will, however, ensure better results. With a highly-bromized collodion, the addition of a drop of concentrated nitric acid to the ounce of bath will often aid sensitiveness; with a collodion poor in bromide this addition must not be made. If doubt exist as to the quantity of bromide, the more neutral condition of the bath had better be maintained.

The iron developer No. 3 (page 45) is suitable. Two other formulæ are given, both of which are effective:—

Ferrous sulphate	60 grains
Water	1 ounce

Or,

Ferrous sulphate	60 grains
Formic acid	$1\frac{1}{4}$ drachms
Alcohol	*quant. suff.*
Water	1 ounce

A pyrogallic acid solution has also been used, viz.:—

Pyrogallic acid	20 grains
Formic acid	1 ounce
Alcohol	6 drachms
Water	1 ounce

It is of the greatest importance that the plate should be covered quickly with the developer. It matters little in this case if part of the free silver solution be carried off the developer; in fact, it is advisable, as the lack of silver prevents too great a reduction on the higher lights before the detail is brought out.

It generally happens that so-called instantaneous pictures require no intensification. If they should require it, the iron and citric acid formula is recommended, as it brings out detail. Care must be taken that harshness is not given to the negative from trying to force out detail, which, in reality, may only pile up the silver on the high-lights without bringing up the half-tones.

Long Exposures.—When long exposures have to be given to wet plates, such as in photographing the interiors of buildings, it may be of some use to give a few details that may be useful.

A collodion which has been iodized long enough to assume a dark straw colour, and to which a grain of bromide of cadmium has been added to each ounce, should be employed. Some photographers employ two collodions, one newly-iodized, and the other very old. A first coating is given with the new, and, after setting, a subsequent one is given with the other.

The plate on immersion in the bath should be kept in rather violent motion till all the greasiness has disappeared (which will be in about two minutes). It should then be taken out very slowly, so as to drain completely. Damp blotting-paper should be placed at its back, and the droppings absorbed in the slide by a strip placed at the lower edge; by this method a plate may be exposed for a long time (two or three hours) without staining or drying. The rationale of this is as follows:—The plate is kept in the bath long enough to change the iodides into iodide of silver, while the *bromide* of silver is only partially formed. The free nitrate of silver left on the plates is absorbed by the bromides to complete the change. This prevents the crystallization of the nitrate of silver on the film. The *nitrates* of cadmium, &c., formed, being very deliquescent, retain sufficient moisture to prevent the film drying.

The exposure for an interior can rarely be too long. The same rule holds good as in ordinary wet-plate photography—viz., expose for the detail in the shadows.

If the sun shines into the windows of the building, its light may advantageously be used, by the use of a looking-glass or tin reflectors. Those parts in the deepest shadows are those to be illuminated by reflected light. The reflector should always be kept moving about, otherwise an opaque patch will be produced on the negative. When a window through which white light is pouring, which is not the principal source of illumination, has to be included in the picture, a yellow cloth or blind should be placed over it till the exposure is nearly complete. This prevents halation or blurring.

No. 3 Developer (page 45) should be used, the contrasts between the high lights and deep shadows being usually extremely marked. Intensification is rarely necessary; if it be, the ordinary formulæ are recommended.

It may happen, no matter what care is taken, that markings like slug tracks and oyster shells show on development. Generally they may be obliterated by brushing a fine tuft of cotton-wool over the defective spots, either when the film is damp and kept covered with water, or when dry. The latter condition is the safer.

The removal of the markings should, in all cases, precede intensification, as the silver would be deposited on them instead of on the image beneath. This would leave the negative intensified at all parts except on those from which the deposits had been removed.

Another method, that has been suggested by Mr. Jabez Hughes, is to wash the plates after sensitizing, and after exposure to redip them. The plate, after having been fully sensitized, is placed in a dish of distilled water, and washed till all greasiness disappears. It is then drained, and placed in the slide, with blotting-paper at the back. After exposure, the plate is redipped in the bath for at least a minute, when it is developed in the usual manner.

Another method is to wash the plate thoroughly after sensitizing, and float over it any of the given preservatives for collodion dry processes, and develop by the alkaline or gelatino-iron development. Perhaps the most simple preservative to employ is a wash of beer to which one grain per ounce of pyrogallic acid has been added.

CHAPTER XIII.

COLLODION DRY PLATE PROCESSES.

There are manipulations common to all collodion dry-plate processes, and it is proposed to detail them here, instead of repeating them with each process. 1st. The plate is cleaned. 2nd. It is given a substratum, or edging, to cause adhesion of the film during development. 3rd. The plate is coated with collodion, and sensitized; or it may be coated with collodion containing the sensitive salts in suspension. 4th. It is coated with a preservative after washing. 5th. It is dried. 6th. It is exposed. 7th. It is developed. In regard to the theory of dry-plate processes there is little difference to that already given under the heading of wet plate processes as regards any of the operations except 2nd, 4th, 5th, and 7th. In these there is a variation to which it is as well to draw attention.

Edging the Plate, or giving it a Substratum.—A plate may be edged with albumen, gelatine, or india-rubber; or the surface may receive a fine coating of any of these bodies, in order to cause adhesion of the film to it during development and subsequent treatment. All of these bodies adhere firmly to glass, and also to collodion, and the fine layer, or edging, the plates receive acts similarly to a mordant in dyeing. It is not always absolutely necessary, when working dry plates, to give either edging or substratum; but, as a rule, it is advisable.

When a substratum is to be given to the plates they should not be polished by the silk handkerchief. It is better to soak them first in potash, then in a dilute solution of nitric acid, and finally to rinse them thoroughly in pure distilled water. They should then be placed in a rack on clean blotting-paper, and be allowed to dry spontaneously. If albumen be employed as the substratum, the following should be made up:—

Albumen	1 ounce (white of one egg)
Water	50 to 100 ounces
Liquor ammonia	5 drops*

The albumen and water should be well shaken together in a bottle for five minutes, and then filtered through fine filter-paper or well-washed tow. The funnel should be lowered nearly to the bottom of the beaker into which the albumen is filtered, to prevent the formation of air-bubbles.

Another formula is here given for use with the dried albumen as supplied by photographic chemists:—

Dried albumen	50 grains
Water	50 ounces
Liquor ammonia	5 drops

The albumen may be dissolved by the aid of heat not exceeding 120°. The solution is filtered in the same manner as the above.

Another plan of preparing albumen for a substratum is due to Mr. Ackland, and described by Mr. Brooks.

The whites of fresh eggs are collected, and to every 8 ounces 1 ounce of water and 24 drops of glacial acetic acid are added, by pouring it into the albumen in a fine stream, and stirring evenly with a glass rod for one or two minutes. The albumen should on no account be beaten or whisked up, or the resulting preparation will be milky. It is allowed to rest one hour or more, and is then strained through coarse muslin or cheese cloth. To the strained albumen is added 1 drachm of the strongest liquid ammonia (·880), when it can be put away in corked bottles and kept for use.

To make a substratum Mr. Brooks takes—

Prepared stock albumen	1 ounce
Water	1 pint

The most convenient method of applying albumen is that

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* Three or four drops of commercial carbolic acid may be substituted for the ammonia.

employed by Mr. Valentine Blanchard. A brush is made of swan's-down calico, as follows:—A strip of glass, about six inches long by two broad, should be produced, and round one end should be attached, by means of thread or by an india-rubber band, a double fold of swan's-down calico. This brush should be dipped in the albumen, and the excess squeezed out against the beaker. The plate should then be brushed smoothly down the surface in parallel lines to within one-eighth of an inch of its edges, set up to dry on blotting-paper, and protected from dust. When dry (which it should be allowed to do spontaneously), the plate will be ready for the collodion.

Fig. 14.

Some prefer to flow the plate with the albumen solution. This is best done on a plate which has been well cleaned but not polished, and which has been subsquently moistened with distilled or rain water. Whilst still wet the albumen should be flowed over the surface as in coating a plate with collodion, and the surplus fluid returned to the stock bottle through the filter. If this plan of giving a substratum be adopted, the solution should only contain 50 ounces of water to 1 ounce of albumen.

Another albumen substratum which is very efficient for collodion emulsion and gelatine emulsion plates is as follows:—

Stock albumen	1 part
Water	20 parts
Silicate of soda (saturated solution) ...	1 part

These are mixed, and after allowing any precipitate to settle, the solution is flowed over the plate. With this, as indeed with all substrata, the plates are free from any tear-marking containing nuclei of dust, if they are dried off over a Bunsen burner or a hot fire. We prefer this last substratum for all processes in which the albumen is not coagulated by silver nitrate, as in all such (as in the washed collodion emulsion process) the albumen is apt to be washed off the plate when applying the preservative, and its application thus rendered nugatory.

Another substratum, which gives even better results than the albumen by itself, is the following :—

Sheet gelatine	75 grains
Distilled water...	60 ounces
Ammonia	¼ ounce

The gelatine should be first softened in 30 ounces of cold water, and then dissolved by adding the remaining 30 ounces of water to it in a boiling state. When cool, the ammonia should be added, and afterwards the solution should be filtered. It is advisable to make it up fresh as required. The addition of one ounce of alcohol has been recommended; the writer has failed to obtain any practical advantage by its employment. The substratum is applied as directed above.

Dr. Vogel gives another substratum, which is also efficacious, and easily applied :—

I.

Gelatine	50 grains
Acetic acid	½ ounce

are placed in a bottle and warmed till solution takes place. This keeps a month.

II.

Chrome alum	10 grains
Water	½ ounce

is next prepared

Take of No. I.	2½ parts
No. II.	1 part
Methylated spirit	70 parts

and filter; coat the plates after cleaning and drying as with collodion, and allow the substratum to dry.

We have used a stronger solution, and found it also to give the required result :—

Gelatine	50 grains
Acetic acid	½ ounce
Alcohol	¾ ,,
Chrome alum solution	1 drachm

This is applied like collodion, and gives a beautifully bright, transparent film. It can be "dried off" against the fire, or over a Bunsen burner.

The formula for the india-rubber solution (which should be poured over the cleaned plate like collodion) is—

India-rubber	1	grain
Chloroform (commercial)	1	ounce

Or,

India-rubber	1	grain
Benzole (rectified)	1	ounce

It will be remarked that all of these solutions are very dilute. If they were of greater strength it would be found that they were excessively liable to cause blisters in the collodion film.

The Collodion for Bath Dry Plates.—The collodion to be recommended is such as will give by the wet process a brilliant and intense negative. The film should not be horny, whilst, on the other hand, it should not be of that character which admits of being easily torn. The writer has found that the addition of water to it causes a greater sensitiveness, doubtless owing to the porous state in which it is left. The following procedure may be adopted:—Take half the collodion to be used in dry-plate work, and drop into it distilled water to such an amount that on coating a plate the film appears slightly reticulated. The remaining half should then be mixed with it, and, as far as the physical nature of the collodion is concerned, it will be found in good condition.

It may be advisable to prepare collodion separate for some processes, and if so, the pyroxyline should be prepared at high temperatures. This is specially the case with certain emulsion processes. The description of its manufacture is given at page 31.

Sensitizing and Washing the Plate.—The bath should be such as will give a good negative by the wet process. It should be of the strength of about 40 grains of silver nitrate to the ounce, unless highly bromized collodion be employed, in which case it may be of the strength of from 60 to 80 grains to the ounce, and the plate should be kept in it for about ten minutes.

Washing the Sensitive Film.—After sensitizing, it is necessary to eliminate the free silver nitrate from the film. The following method will be found efficient. Two flat dishes or dipping baths should be filled with distilled or purified water, and immediately after the plate is taken out of the bath it should be placed in one of them. It is of great consequence that the plate should be immersed in the water without stoppage. When using a flat dish a certain knack is required to effect this. The most successful method is to hold the plate nearly touching the surface of the water, and then to allow the plate to sink by its own weight. With a little practice, an even circular wave moves over the surface, and there will be a consequent freedom from markings due to this part of the preparation.

When the ether and alcohol have been absorbed by the first washing (which is known by the absence of all "greasy" appearance on the surface), the plate should be removed to the second dish or bath, and be allowed to remain at rest for four or five minutes.* It is then washed under the tap for a couple more, and finally rinsed with distilled water, when it will be ready for the preservative.

The Preservative and its Mode of Application.—At page 3 it was stated that a preservative was used to absorb the iodine and bromine liberated by the action of light from the silver iodide and bromide present in the film. It has other uses, however, the chief one being the prevention of the access of the atmosphere to the sensitive salt. Without such protection the latent image would become oxidized, and, consequently, undevelopable (see page 19). Let it here be remarked that the presence of moisture is absolutely necessary in the preservative to ensure sensitiveness. A plate which is thoroughly desiccated is very insensitive. Hence, in dry climates, precautions of some kind must be taken to be certain of its presence. The preservative is usually applied by floating it on the surface for about a minute. It is a good plan to allow the solution from one plate to flow back into the cup, and to use it for the first flowing of the next plate, and then to apply fresh. By this means dilution from the water on the surface of the film is avoided. Some operators, in certain cases, apply the preservative by immersing the plate in a flat dish or dipping bath, containing the solution. As a rule,

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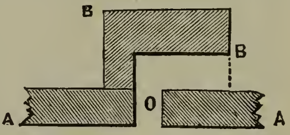
* If the plates are required to be kept but a short time (say three or four weeks), a minute's washing under the tap is sufficient. The plate will be rather more sensitive than if the washing be prolonged. In the case where the preservative is washed off, one minute's washing suffices.

this procedure is not to be recommended, as any contamination from one plate is liable to be carried on to another.

Drying the Plate.—After applying the preservative, the plate is usually dried spontaneously, but sometimes by the aid of heat,* the temperature being maintained below 212°.

To the photographer who works with home-made dry plates a perfect drying-box is a *sine quâ non.* It may be taken for granted that the larger the box the more even will be the drying of the plates, and consequently the better chance of perfection in the negative.

An ordinary cupboard may be converted. The shelves at the back edge should be pierced with holes close together, or an interval left between them and the back of the cupboard. About two and a-half inches from the back, small tumblers† (such as described for developing cups) should be let into the shelf, the rim projecting about half an inch above the shelf itself. Small strips of glass should then be fastened round the cupboard, at such a height that when the corners of the plates which are to be dried rest in the tumblers, the opposite corners should rest against them. Ventilation should be secured by boring holes at the top and bottom, covering them with strips containing L-shaped holes. The accompanying diagram shows the form. A A, the top of the cupboard; B B, the strip of wood screwed on to cover the aperture O. The inside of the L-pieces and the side of O should be blackened, to prevent any reflection of light. If hot water or hot-air pipes can be passed through the cupboard, the rapidity of drying will be increased. In this case, over the pipes, and at a distance of six inches from them, should be placed a sheet of perforated zinc. This will equalize the distribution of the heat to a great extent.



If a drying cupboard is to be constructed, a good type is that shown in fig. 15 (page 94), since it will do for either gelatine or collodion plates. It is Mr. England's plan, and if constructed as in the sketch, would take any plates up to 12 by 12.

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* The plate should never be altered in position whilst drying, for if it be, a mark is sure to appear round the portion only partially desiccated.

† The small porcelain or glass ink pots used for school desks are equally good.

A box is made of the dimensions given, and one side is hinged, and opens as shown. This side has a fillet placed round it, so that, on shutting up, no light can enter the interior of the box. Through the centre of the box runs a gas pipe, at the bottom of which is inserted a small tube closed at the end, and on the side of which is pierced a small hole. To this hole gas is led, and a very small jet is lighted in the gas pipe. At the bottom of the box, and at the top, are two holes of about three to four inches diameter, and above two tin tubes, some twelve inches long, are fitted into these tubes as shown in the diagram. It will be noticed that the gas piping passes through the centre of these two tubes. Round the gas pipes are fitted two discs of blackened card or tin, one of which is placed two inches above the bottom hole, and the other the same distance from the top hole. These prevent light striking down the tin tube into the

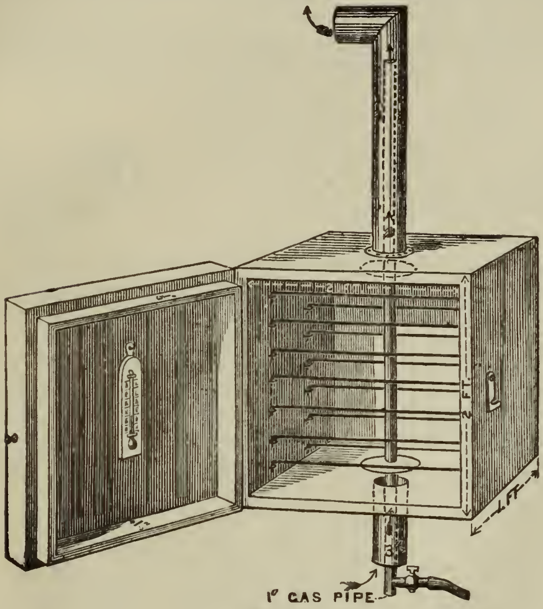

Fig. 15.

box. When gelatine plates are to be dried, pairs of wires are to be stretched across the box, as shown in the diagram.

Glass or slate strips may be substituted for the wires. For plates 8½ by 6½, slips three inches wide are sufficient, and they should be a quarter-inch thick to prevent bending. One end of the slip is supported in a stirrup shown in the figure, in the top of which is a slot, through which a screw is passed into the cupboard; opposite to this is another stirrup, into which are inserted two thumbscrews as shown. This is placed exactly opposite the first stirrup in the cupboard. The strip is placed between these two stirrups, and is first levelled crossways by means of the thumbscrews. When level in this direction the length of the strip is levelled by raising or lowering the first stirrup, and when in position the screw in the slot is screwed home. When once levelled, the strip will always fall level into position. Gelatine plates are at once placed on these shutters, and allowed to set in the position in which they are to be dried.

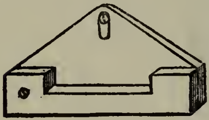
Fig. 16.

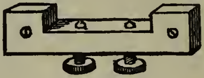
Fig. 17.

It has been stated that markings in gelatine plates may be met with owing to the emulsion setting more rapidly in those parts of the plate which are in contact with the strips. If such should be feared, we recommend threading beads on a string and tying them round the strips at proper intervals. The setting will then take place without any chance of drying markings, since the plate will be supported by points. This plan is very suitable for warm weather, when gelatine plates take long to set. Strips of board in which are thumbscrews may be substituted for the glass shelves, and these may be levelled.

We have lately adopted a plan of drying plates in racks which enables more to be dried than in the methods just given in the same cupboard. The racks are made as in fig. 18. They consist of three upright pieces of ½-inch square deals let into two triangular pieces of ¾-inch deal. The former are so arranged that a corner of each faces inwards. In two of them, small iron pins are driven, on which the bottom edge of the plates rests. The tops of the plates are supported by the angle of the third deal bar as shown. A cupboard will dry nearly double as many plates on these racks as when they are laid to dry horizontally.

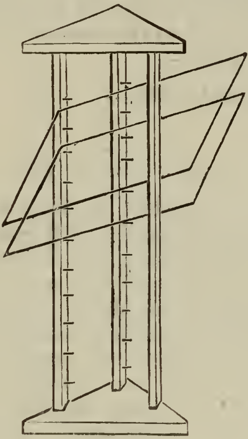

Fig. 18.

The temperature of the cupboard should be kept as even as possible, sudden changes being detrimental—producing markings. Opening the drying cupboard door before the plates are dry, when once the gas has been turned on, is a mistake; the plates should be left until it is judged they are quite dry. Very quick drying is a mistake, both for collodion and also for gelatine plates. The temperature should, if possible, not exceed 80° F. for the latter, and the gas must be regulated accordingly.

When collodion dry plates are to be dried, the wires or slabs are best removed, and little movable shelves fitted round, in which the small tumblers are placed as above.

Plates dried in such a drying-box are ready for use four or five hours after coating. A small thermometer should be hung on the cupboard door, to enable the temperature to be noted.

The rationale of this fairly rapid drying is that the gas piping gets heated, warms the air in contact with it, which ascends through the top tin tube, and a current of fresh air comes up through the bottom one. A constant change of air, more than a very dry or hot air, is the object to be attained.

Backing the Plate.—With some kinds of plates, more particularly if a gum or albumen preservative be used, the films are very translucent, and the image is subject to halation (see Chapter V.) This defect is in a measure cured by applying some non-actinic varnish to the back of the plate. This backing may be made as follows:—

Powdered burnt sienna...	1 ounce
Gum	1 ,,
Glycerine	2 drachms
Water	10 ounces

The solution can be brushed on with a hog's bristle brush. Ordinary printer's paper coated with gum-arabic, stained with aurine or a blue absorbent dye, and fastened on the plate, is as clean a method of backing a plate as can be desired. Whichever backing is employed, it should be removed previous to the development of the plate, and it is often convenient to do so after the alcohol has been applied to the surface of the film, and before washing with water. The alcohol repels any water containing the soluble part of the backing, and thus prevents staining of the image. A small tuft of cotton-wool will remove the backing given above.

Collodion stained with aurine may also be used, but with collodion plates this is somewhat difficult. The most perfect backing is a thin solution of asphaltum in benzole. This must be applied to back of the plate when dry.

Fol has introduced another backing, which is made as under:—

Gelatine	50 grains
Glycerine	2 drachms
Water	1 drachm
Indian ink	Sufficient to blacken

Stout paper or shirting is coated with the above, and the sheets laid to set face downwards on a glass plate. When dried, they are pressed against the back of the glass plate, and can afterwards be easily stripped off.

CHAPTER XIV.

DEVELOPERS FOR COLLODION DRY PLATES.

Iron (Acid) Developer.—The following is a standard for gum-gallic dry plates :—

No. 1.—	Gelatine (any kind will answer)	64 grains
	Glacial acetic acid	2 ounces
	Water	14 ,,
No. 2.—	Ferrous sulphate	30 grains
	Water	1 ounce

Half the quantity of water in No. 1 should be taken, and the gelatine be allowed to soak till it be thoroughly swelled. The remaining half of the water should be added in a boiling condition, which will cause solution. The acetic acid should next be added, and the whole allowed to cool.

One part by measure of No. 1 should be mixed with three parts of No. 2, and then filtered. It is inexpedient to *mix* more than is necessary for one or two days' use, as the iron undergoes oxidation. No. 1 will keep indefinitely, whilst No. 2 should be made as required.

To every drachm of developer used, one minim of a solution of silver nitrate (30 grains to the ounce) should be added just previous to its application to the plate.

Plain Pyrogallic Acid Developer.—The following is the formula used with some kinds of plates :—

Pyrogallic acid	3 grains
Water	1 ounce

To bring up the image to printing density, the following is applied with three or four drops to each ounce of a solution of silver nitrate (30 grains to the ounce of water):—

Pyrogallic acid	2 grains
Citric acid	½ grain
Water	1 ounce

Acidified Pyrogallic Acid Developer.—The developing solutions are—

No. 1.—	Pyrogallic acid	144 grains
	Alcohol	2 ounces
No. 2—	Silver nitrate	60 grains
	Citric acid	60 ,,
	Distilled water	3 ounces
Take of	No. 1	16 drops
	No. 2	8 ,,
	Water	1 drop

Flow this over the plate till the detail is well out, when five or six drops more of No. 2 must be added to give intensity.

Alkaline Developer for Bath Dry Plates.—We come now to the more modern developers, originally used in America, made practicable first of all by Major Russell, and subsequently improved by many other workers. The proportions for gelatine plates are different.

No. 1.—	Pyrogallic acid	6 grains
	Water	1 ounce
No. 2.—	Potassium bromide	20 grains
	Water	1 ounce
No. 3.—	Ammonia (·880)	1 part
	Water	32 parts

To every two parts of Nos. 1 and 2 one part of No. 3 is added. It is well to flood the plate for a second or two with the mixture of Nos. 1 and 2 before adding No. 3. This prevents irregularity in development, and will be found in the chapter treating of the development of these plates.

Another form of *the same developer* is as follows:—

No. 1.—	Pyrogallic acid	96 grains
	Methylated alcohol	1 ounce
No. 2.—	Potassium bromide	12 grains
	Water (distilled)	1 ounce

No. 3.—Ammonium carbonate	80 grains
Water (distilled)	1 ounce

Or,

Liquor ammonia	25 minims
Water	1 ounce

To develop the plate, take of—

No. 1	6 minims
No. 2	½ drachm

(Half the quantity in cold weather.)

No. 3	3 drachms

These alkaline developing solutions, of either formulæ, should be mixed immediately before use, and, after well stirring with a glass rod, be flowed over the plate. When the detail begins to appear, the bulk of the solution should be poured back into the developing glass, and the appearance of the image watched. If the detail appear slowly and regularly, the developer should be again flowed on the plate, and the image be allowed to gain full density. If, however, it appear very slowly, and with apparent difficulty, another drachm of No. 3 should be added to the solution in the glass, and again be applied to the film. If the detail flash out at once, the action must be instantly checked by water, and another half drachm of No. 2 be added to the developing solution, which should be again applied.

Ferrous-oxalate Developer.—A saturated solution of the neutral potassium oxalate is first prepared. A crystal of oxalic acid is next added, to prevent the slightest trace of alkalinity. At one time we used to add ferrous-oxalate to a warm potassium oxalate solution, only so much of the oxalate being added as to leave a slight portion of the ferrous compound undissolved. We prefer now to add the ferrous-oxalate to the cold saturated solution of the potassium salt, and to allow them to remain in contact with one another for twenty-four hours, shaking occasionally. The clear solution can be decanted off. This method prevents the deposition of crystals on the sides of the bottles, which always are deposited if the ferrous-oxalate be heated with the potassium oxalate. The solution will be of a deep red colour.

The ferrous-oxalate solution rapidly oxidizes by contact with the air, as already hinted at, and our own practice is to fill 4-ounce bottles with it, cork them up, and then to lute the corks with solid paraffin. Mr. Warnerke adopts the following plan. He uses a large stoppered bottle having an opening near the bottom, such as can be procured at any chemical dealer's. Into this opening he fits a cork carrying a small glass tube; on to the end of this (outside the bottle, of course) he fits a piece of india-rubber tubing, and connects this with a similar piece of bent glass tubing, which reaches nearly as high as the top of the bottle. He fills the bottle two-thirds way up with the ferrous oxalate solution, and then pours in a layer of liquid paraffin. This prevents any access of air to the solution. To get at the solution, the bent tube is turned down below the level of the paraffin, and the developing cup or bottle filled.

Dr. Eder's Ferrous Oxalate.—Mr. York, working on the directions of Dr. Eder, gives the following formula:—

No. 1.

Ferrous sulphate	160 grains
Water	1 ounce

No. 2.

Potassium oxalate (neutral)	1 ounce
Water	3 ounces

This makes up 4 ounces of developer, and by using these quantities, saturated solutions are obtained. Personally we prefer four parts of No. 2 to one of No. 1.

Strong Ferrous-Oxalate Developer prepared with Ferrous Sulphate.—A still stronger form of ferrous oxalate developer can be made by taking a saturated solution of potassium oxalate and adding to it *crystals* of ferrous sulphate. These must be added cautiously, since part of the potassium oxalate is converted into ferrous oxalate, and the remainder holds it in solution.

Mr. York's formula for the potassium oxalate may be taken, and to it 200 grains of sulphate of iron be added (powdered up in a mortar by preference). It will probably be found that some of the yellow oxalate will precipitate, in which case *crystals* of potassium oxalate must be added to the solution till such precipitate is re-dissolved. It will be seen that in developing collodion dry plates a certain proportion of potassium bromide has to be added.

Ferrous-Citrate Developer.—The following is the method of making ferrous-citrate developer according to Dr. Eder and Capt. Pizzighelli's plan:—600 grains of citric acid are dissolved in 4½ ounces of water with the aid of heat, and exactly neutralized with ammonia; 400 grains of citric acid are then added, and the bulk of the fluid made up to 9 ounces of water; 3 drachms of this solution are mixed with 1 drachm of a saturated solution of ferrous sulphate and 12 minims of a solution of sodium chloride (of 16 grains to the ounce of water).

Ferrous citrate may be purchased and dissolved in a saturated solution of ammonium citrate, adding citric acid if required to give a clear picture.

Ferrous-Citro-Oxalate.—This developer, introduced by the writer, is made as follows:—

*Potassium citrate (neutral)	100 grains
Ferrous oxalate	22 ,,
Water	1 ounce

The potassium citrate is first dissolved in a flask by heat, and, when nearly boiling, the ferrous oxalate is added, and shaken up in it, a cork being used to prevent the access of air to it. This quantity of ferrous-oxalate should just dissolve. It may be cooled by allowing cold water to flow over it, and should then have a citrony-red colour.

It may also be made in the cold by the following solutions:—

No. 1.—	Potassium citrate	700 grains
	Potassium oxalate	200 ,,
	Water	3½ ounces
No. 2.—	Ferrous sulphate	300 grains
	Water	3½ ounces

These two solutions are mixed in equal proportions.

A weaker solution is made the same way with the following formula:—

Potassium citrate	50 grains
Ferrous oxalate	12 ,,
Water	1 ounce

These solutions keep well when corked up in bottles. There is

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* Potassium citrate can be obtained at any druggist's, as it is employed in medicines.

no deposit from keeping even when oxidized, which is shown by the solution turning an olive green colour. Any plates may be developed with the ferrous citrate, or ferrous-citro-oxalate, without the addition of any restrainer such as potassium bromide.

Hydrokinone Developer.—This developer has a slightly greater developing power than pyrogallic acid. To make a normal developer—

No. 1.

Hydrokinone	6 to 12 grains
Water	1 ounce

No. 2.

Carbonate of ammonia in water, a saturated solution; to every ounce of No. 1 use 1 drachm of No. 2.

Hydrosulphite Developer.—There is another developer, introduced originally by M. Sammann, of Paris, which is popularly called the "hydrosulphite developer." It has not been much employed, owing to the trouble there is in making it. Make the following stock solutions:—

1.—Pyrogallic acid	1 ounce
Saturated solution of salycic acid in water	20 ounces
2.—Sodium bisulphite...	1 ounce
Sodium sulphite	30 grains
Water ... ... ,..	4 ounces

20 grains of sodium borate may be substituted for the sodium sulphite.

When it is required to make the sodium hydrosulphite, a vial is half filled with granulated zinc, and enough of this solution is poured in to fill up the interstices. After half an hour the reaction is complete. The solution is poured off into a stoppered bottle, where it will keep, but only for a few hours.

The zinc and vial must be well washed in order to be ready for the next quantity which may be required. M. Sammann says that the bisulphite must be quite free from sulphurous acid, which, if present, must be neutralized by sodium carbonate. One part of it should dissolve in two parts of water at the ordinary temperature.

Before development, the plates are flooded with a solution of—

Tannin...	10 grains
Water	1 ounce.

They are then washed and drained. One part of No. 1 and four parts No. 2 are then mixed together, and placed in a dish containing the plate, which is just big enough to hold. When all the detail is well out, it is probable that the negative will have sufficient printing density, as the development is very slow and gradual. If the pyroxyline be of too "organic" a character, a white veil is sometimes seen on the shadows, which, however, disappears on varnishing. The intensity, if lacking, may be given in the usual manner by pyrogallic acid and silver, according to the formula given at page 48. Mr. Berkeley states that this developer may be made alkaline with ammonia, in which case the sodium sulphite may be omitted.

CHAPTER XV.

DETAILS OF DRY PLATE PROCESSES WITH THE BATH.

The Gum-Gallic Process.—This process was first introduced by Mr. R. Manners Gordon, and in his hands, and those of many photographers, has proved of great value. The negatives are possessed of remarkable delicacy, and have an appearance similar to wet plates. The plate should have a substratum (see page 90); an edging in the case of small plates suffices. After development, the film will probably blister if only an edging be given, and by soaking in water these blisters may be caused to join and give a loose film, under which will be a layer of water. The corner of the film should be pricked, and the water drained out.

To ordinary good collodion should be added a grain per ounce of cadmium bromide, and the plates kept in the bath for seven minutes in summer, and ten in winter, in order to convert the greater part of the bromide into the silver salt. They should be worked up and down in the solution till all greasiness has disappeared, and should then be left quiet till just before withdrawal.

After washing, the preservative is applied; it is made as follows:—

No. 1.—	Gum-arabic	20 grains
	Sugar-candy	5 ,,
	Water	6 drachms.
No. 2.—	Gallic acid	3 grains
	Water	2 drachms.

No. 2 is prepared with the aid of heat, and is then mixed with No. 1 in the proportions indicated.

The gum-arabic should be that known as "picked;" that is, all yellowish lumps should be rejected, nothing but the white being used.

The water used should be distilled, rain, or purified. If it contain iron in appreciable quantity, it is fatal to success.

To filter this solution, which contains gallic acid, great care should be taken to select a thin filtering paper which is free from iron. The presence of this impurity will be indicated by the solution turning an inky colour. The solution will be found to run through the paper better if kept warm.

A further aid to filtration will be given by the following contrivance, which, it may be noted, will serve to aid the filtration of most viscous bodies.

A cork or india-rubber stopper is pierced with two holes. Through one is passed a funnel containing a platinum foil support for the filter paper, and through the other a bent tube as shown in the sketch. By means of india-rubber tubing, this last can be connected with either an exhausting syringe, a Bunsen water-pump, or an aspirator of the usual form. Attaching a length of india-rubber tube to glass tube, closing one end by nipping with the fingers of one hand, and then drawing back the air which is in the tube by running the fingers of the other hand along it, is usually sufficient to exhaust. The partial vacuum thus made causes the solution to pass with tolerable facility through the filter paper. Another aid will be found described in the filtering of gelatine emulsions.

The preservative is applied by floating it on the surface for about one minute. The plate must then be allowed to drain, and finally be allowed to dry spontaneously in the drying-box. If the plate, previous to exposure, appear dull, it should be dried by artificial heat before being placed in the dark slide.

Exposures.—Great latitude in exposures is admissible; it should rarely be less than four times, nor more than twenty times, that which would be required for wet plates under ordinary circumstances; though with the alkaline developer (for which see page 100) the exposure may be reduced to that necessary for a wet plate. That is to say, with a lens of aperture $\frac{f}{16}$ and an open view without much heavy foreground, and in good spring light, 20 seconds' exposure should suffice. The development by this method is similar to that given at page 101. Some recommend its employment if the plate be kept for a long period (say a month) between exposure and development. The acid iron developer yields splendid negatives from a well-exposed and well-prepared plate (see page 100).

To develop the image, the backing (if any) must first be entirely removed with a damp rag, or peeled off in the case of paper backing. The plate should then be immersed in a dish of water of not less than 65° Fahr. for two or three minutes, to soften the gum, and be finally rinsed under the tap. The developer (page 100) should now be flowed over, and, if properly exposed, the image will begin to appear almost immediately. As it appears, more silver solution must be added, by two or three drops at a time, till the whole of the detail is visible. The film must next be well washed, and intensity gained by the ordinary pyrogallic acid intensifier and silver solution (page 49). The negative should have all the characteristics of a wet plate, if properly manipulated. Should it be inferred that the plate is over-exposed, more of No. 1 may be added to the developer. It is important that the silver solution be added to the developer previous to flowing over the plate. If the latter be applied alone, and then silver be added, the resulting negative is liable to be granular in appearance.

Ferrous oxalate (see page 100) development may also be used most effectually. The mode of employing it is the same as given for collodion emulsions. It should be followed up by the ordinary intensifier, such as described at page 49.

The Coffee Process.—There have been various modifications of this process; the best, as far as experience has taught, is that of M. de Constant. It is thoroughly reliable, and the plates prepared by this method keep well, and give soft negatives.

The collodion to be recommended for this process, according to M. de Constant, is ordinary collodion, with the addition of two grains of cadmium bromide to the ounce. If collodion be home-made, the pyroxyline should be manufactured at a high temperature in the acids (see page 31), and may be known in commerce by its yellow appearance, and by being found to separate in short rather than in fibrous particles.

The plate is given a substratum ; it is then coated, and the film sensitized and washed in the ordinary way, as described at p. 106.

The preservative is formed as follows :—

No. 1.—Boiling distilled water	... ...	5½ ounces
(Mocha) coffee	... ...	½ ounce
White sugar	... ...	90 grains
No. 2.—Distilled water	... ...	5½ ounces
Gum-arabic ...	... ...	90 grains
Sugar-candy	... .	20 ,,

No. 1 is allowed to cool in a well-corked bottle, and both solutions should then be filtered (see page 92) and mixed. It is found convenient to pound the gum-arabic and sugar-candy in No. 2 before adding the distilled water.

The film may be coated with the preservative in the ordinary manner, two applications of a minute's duration being necessary. It is *better* to use a flat dish to *immerse* the plate in for two minutes, as evenness of coating is thereby insured. The plate should be then placed on end, upon folds of blotting-paper, to drain, previous to placing it in the drying-box.

The usual precautions for drying are to be observed in this as in the last process. When thoroughly dry, the surface of the film assumes great brilliancy, and exhibits neither stain nor fog by transmitted light. If a cloudy aspect shows on portions of the film, a heated flat iron passed over it, an inch from the surface, will restore the brilliancy, and the plate will be fit for use.

M. de Constant stated that the exposure required for these plates was three times the length required for wet plates, under precisely similar circumstances. It is better to give six times the exposure, as the development is easily controlled in a slightly over-exposed picture. It is stated that a comparatively longer exposure is requisite in bright sunshine than in cloudy weather.

With these plates there is a tendency to blurring of the image. In such a case, "backing" must be given (see page 98).

Before development, the plate should be covered with, or else immersed in, rain or good ordinary water for three or four minutes, and kept in motion. The water should then be drained off. For an 8½ by 6½ plate, the following must be flooded over the plate :—

*Saturated solution of carbonate of ammonia	8 drops
Water	4 drachms

This is worked over the plate till the image begins to appear, and till there is no further action caused by it, and it is then returned into the developing cup, in which must have been dropped from one to two drops of the following solution :—

Pyrogallic acid...	60 grains
Alcohol...	1 ounce

The ammoniacal water, with this solution added, should be swept over the plate in a manner similar to that employed in developing a wet plate, as its action is extremely rapid. The image will now appear fully by reflected light, but be barely visible by transmitted light. The action of this solution must be continued till every possible detail in the shadows is brought out. The image may now be intensified by the ordinary pyrogallic intensifier (page 49); but by this method it will always appear transparent. To prevent this, M. de Constant recommended the following before the final pyrogallic intensification :—

Ammonio-sulphate of iron	45 grains
Copper sulphate	45 ,,
Citric acid	45 ,,
Water	3½ ounces

It will remain in good condition for a considerable length of time.

Two or three drops of a 20-grain solution of silver nitrate may be added to this after the first application. On the second application the negative becomes of a colour resembling that of a wet plate. The ordinary intensifier should be used after this. If the negative tend to become solarized (*i.e.*, to turn a reddish colour in the shadows), it should be fixed at once, and intensification take place afterwards.

The plates may be developed by the alkaline developer (page 100), or by the ferrous oxalate developer (page 101), with which the image is more opaque than when any form of alkaline developer is employed. See, also, Collodion Emulsions.

Either sodium hyposulphite, or a weak solution of potassium

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* One drop of concentrated liquor ammonia may be substituted.

cyanide, may be used for fixing the image. If the latter agent be used, M. de Constant prescribed that a few drops of acetic acid should be dropped into it before application, to prevent blistering. The efficacy of this we cannot vouch for.

The Collodio-Albumen Process.—The collodion should be very old and powdery. The dregs of different samples may all be thrown together, and, though almost entirely insensitive for the wet process, it will be found to be no drawback for this; even collodion that sets opalescent is suitable. Mr. Mudd, whose exquisite landscapes were produced by this method, advises that it should contain no bromide; other workers do not insist on this condition.

The ordinary negative bath is used. The plate, being sensitized as usual, is washed thoroughly till all the free silver nitrate is removed.* The plate is then flowed over with the following :—

Albumen	8 ounces
Ammonia ·880...	2 drachms
Potassium iodide	50 grains
Potassium bromide	10 ,,
Water	2½ ounces

This operation should be repeated twice, taking fresh solution every time. The salts are first dissolved in the water, next the ammonia added, and then the solution mixed with the albumen. The whole is then beaten to a froth, and allowed to settle, and the clear liquid decanted or syphoned off for use. The eggs should be fresh, if possible. Before use, the solution should be filtered through a piece of sponge plugged into a funnel. The great enemy to this process is the formation of bubbles. These may be avoided by keeping the funnel touching the bottom of the glass beaker into which the albumen is filtered.

The plate is next slightly drained, and set up to dry. At this stage it is quite insensitive to light if no bromide be present in the collodion, and will keep indefinitely. Before use, resensitizing must take place. A bath must be prepared made as follows :—

Silver nitrate	30 grains
Glacial acetic acid	½ drachm
Water	1 ounce

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* It may be immersed in a solution of potassium iodide, one grain to the ounce of water, to secure this result.

Into this the dried plate must be dipped, and be allowed to remain in it for at least one minute—ten minutes will not hurt it. After withdrawal it must be *thoroughly* washed, and then be set up to drain. When the excess of water has been absorbed, it is placed in the drying-box, and allowed to dry spontaneously. The bath solution soon becomes reddish in colour, owing to the organic matter which is dissolved out from the albumen film; but it does not affect the resulting sensitiveness.

Plates thus rendered sensitive will keep for a week in hot weather, but longer in cold.* The newer the plates the better will be the result. They will keep after exposure, which is of great advantage to the tourist.

The required exposure is long—in fact, it is almost impossible to over-expose; at least ten times the exposure of an ordinary sensitive wet plate should be given, whilst twenty times would be better.

To develop, wash the plate thoroughly, and apply the plain pyrogallic solution, page 99.

After a few minutes the outline of the sky will appear by reflected light, though nothing will be visible by transmitted light. *Nearly* all the detail should be brought out, and but little left to be done by the subsequent intensification. A considerable quantity of unaltered iodide should be visible in the image.

The density is brought up by pyrogallic and citric acid solutions belonging to the same formula (page 115).

During intensifying a slight deposit may take place on the surface of the film. This can be removed by carefully wiping it with a tuft of wet cotton-wool. When of proper strength the image should be fixed with sodium hyposulphite (see page 52).

An under-exposed picture may be forced up by using the plain pyrogallic solution warm, or of double or treble the strength given at page 99, or also by alkaline development as for the albumen-beer process (page 115).

The sky in the picture produced by this process is rarely sufficiently opaque. Painting out—an operation tedious, and often unsatisfactory—or some similar artifice must be adopted.

England's Collodio-Albumen Process.—A very useful modification of the foregoing has been introduced by Mr. England.

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* If a saturated solution of gallic acid be applied after the final washing, the plates will keep sensitive for a month or more.

The plate is cleaned, sensitized, and thoroughly washed. It is then flowed over with diluted albumen. (The white of one egg to one ounce of water in cold weather, and two ounces of water in hot weather. These are well shaken up in a bottle till the albumen is thoroughly incorporated with the water, and the solution is filtered through sponge.) The plate is next rinsed to free it from superfluous albumen, and a silver solution (made similarly to the bath, acidified with acetic acid in the last process) is flowed over the film without any stoppage, and allowed to remain on it for a minute. It is then thoroughly washed, and allowed to dry spontaneously. The exposure is about the same as for a gum-gallic plate, and the development is conducted as for the collodio-albumen process.

Hot Water Process.—The last process may be varied by immersing the plate, immediately after it is floated with the preservative, in boiling water, to coagulate the albumen, and flowing over it a saturated solution of gallic in water, and setting up to dry. The development may be carried on as above, or by the alkaline method.

Tannin Process.—With this process bromo-iodized collodion is to be used. The plates require a substratum or an edging. After well sensitizing, they are thoroughly washed in distilled water, then under the tap, and finally rinsed with distilled water. The preservative—

Tannin (pure)	10 to 15 grains
Distilled water	1 ounce

is then flowed over them. (The addition of gum ten grains, and sugar five grains, is recommended by some, but the advantage is not very apparent.)

The exposure required is about one-and-a-half times that of a gum-gallic plate.

To develop, the plate is flooded with equal parts of alcohol and water, washed, and acidified pyrogallic acid developer (page 100) used.

These plates are sometimes most satisfactory, at other times they are full of pinholes and stains. A good batch will keep well for two or three months.

This process may also be carried out by using a collodion containing nothing but bromide; the formula for which is—

Ether	½ ounce
Alcohol	½ ,,
Pyroxyline	6 grains
Cadmium bromide	8 ,,

The plate coated with this collodion is immersed in a bath of the following—

Silver nitrate	80 grains
Water	1 ounce

No iodide need be added. The remaining operations are similar to those described above. Alkaline development, described for the coffee process, may be employed.

With a strong alkaline developer (page 100) the exposure is shortened to that of a wet plate.

Albumen Beer Process.—The following process was introduced by the writer for solar photography, and was employed in the English Transit of Venus Expedition for 1874. It is, however, equally adapted for landscape work, and is very certain in its results. The collodion employed can be that described at page 106, though for more rapid work the following is better:—

Alcohol (·825)	4½ to 3 drachms
Ether	3½ to 5 ,,
Pyroxyline	7 grains
Ammonium iodide	2 ,,
Cadmium bromide	5 ,,

The relative proportions of ether and alcohol are adjusted according to the temperature in which the plates have to be prepared.

With the ordinary samples of collodion the usual 40-grain silver nitrate bath can be used, but with the collodion made as above it is advisable to use a bath made up to 60 grains, preparing it as given at page 43. It has also been found advantageous to dip the plates in the weaker bath at first, allowing them to remain in it for a couple of minutes, and then to transfer them to the stronger bath for ten minutes more. This mode of procedure gives very sensitive and opaque films, the greater part of the actinic rays being thus utilized. The sensitiveness, however, greatly depends upon the porosity of the film, and every effort should be made to attain the maximum of this quality without injuring its texture. The addition of the largest practicable amount of water to the collodion tends to give this quality. After sensitizing, the plate is slightly washed, and then the first preservative applied, which is—

Albumen	1 fluid ounce*
Water	1 ounce
Ammonia	1 drachm

This is beaten up into a froth (or is mixed by pounding it in a mortar with silica), and when settled, the clear liquid is decanted off. This solution is mixed with equal quantities of any ordinary beer or stout immediately† before use, and is floated over the plate. (When bottled beer is used, it is advisable to drive off all the carbonic acid by a gentle heat.) The excess is drained off, and the film thoroughly washed under the tap for a couple of minutes, and is finally covered with a solution of plain beer to every ounce of which two grains of pyrogallic acid have been added.

The plate is dried in the ordinary manner (page 95).

The exposure, with well-prepared dense plates, is at least as short as that necessary for wet plates, but great latitude is admissible. With twenty times the minimum exposure, a good negative can be obtained. In very dry climates the sensitiveness rapidly diminishes owing to the water being completely eliminated, and this is a necessary part of any sensitizer when its full power is to be exhibited.

The development need not be effected for a month after exposure. The following solutions are required:—

No. 1.—	Pyrogallic acid	12 grains
	Water	1 ounce
No. 2.—	Liquor ammonia (·880)	1 part
	Water	4 parts
No. 3.—	Citric acid	60 grains
	Acetic acid	30 minims
	Water	1 ounce
No. 4.—	Silver nitrate	20 grains
	Water	1 ounce

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* Dried albumen, 25 grains, may be substituted for the fluid ounce.

† This precaution is necessary, otherwise the tannin of the beer is precipitated by the albumen.

The washing water before development should be of a temperature not less than 60° Fah. When washed as directed (p. 92), the following developer is employed :—

To each half ounce of No. 1 are added three drops of No. 2, and, after well mixing with a stirring-rod, the solution is flowed over the plate.

Almost immediately the image begins to appear, and, after a few seconds' interval, the detail can be seen by reflected light to gradually develop. Another two drops of No. 2 are again added to the solution, which is once more flowed over the plate. Six drops of No. 3 are next dropped into the developing cup, and the solution from the plate poured on to it. Again the plate is rinsed, this time by the acid solution, and intensification is given by the use of it with a few drops of No. 4. It is not advisable to allow too much detail to come out with the alkaline solution, but to allow a portion of it to be brought out by the subsequent treatment with the pyrogallic acid and silver. The alkaline developer reduces the bromide salt, and leaves the iodide to be attacked by the silver solution. It will be remarked that no restrainer such as bromide is employed; the albumen dissolved by the ammonia plays the part of a retarder, but not as a destroyer of the latent image.

When the image appears sufficiently dense, it is fixed either by sodium hyposulphite or by potassium cyanide.

A Tea Process.—Of all dry processes, the tea process is the most charming, when exposure can be given to the plates within two or three days of preparation. They can be developed by the acid iron developer (page 99), or by the alkaline developer (page 100). They possess a beauty not obtainable by most processes.

The plate is coated with a bromo-iodized collodion, sensitized as usual, a preliminary coating or edging having been given to it. After thorough washing, it is *immersed* in an infusion of tea. This latter is prepared by pouring about ten ounces of boiling water on half an ounce of good black tea. After standing one or two hours it is filtered, and is ready for use. It will not bear the addition of either gum or sugar. The plates require about three times the exposure of wet plates, and should be developed within twenty-four hours of the exposure.

CHAPTER XVI.

DEFECTS IN DRY PLATE NEGATIVES WITH THE BATH.

Besides the defects that are common to both wet and dry plate processes, the following may be met with.

Blisters.—If blisters* make their appearance, it is probable, if the substratum be of albumen, that the solution is not sufficiently dilute. With some kinds of india-rubber, blisters always appear.

Transparent markings may be caused by handling the plate with warm fingers before immersion in water previous to development. The corners of the plate alone should be touched.

Large opaque spots may be caused by allowing a warm finger to touch the plate during preparation or development.

A transparent edge will be caused by allowing the whole length of the edge of the plate to rest on blotting-paper when drying in the drying-box.

A lack of density is caused by the collodion being too thin, requiring more pyroxyline; by an insufficient quantity of bromide and iodide; by insufficient sensitizing in the bath; or by too weak an alkaline developer.

Lines may be caused by a stoppage in the flow of the developing solution; by moving the plate in the drying-box previous to complete desiccation; or by an uneven flow of the preservative over the film.

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* Warming the plate, and then cooling it just previous to coating with collodion, is of service, preventing blisters.

Black spots on the film may be due to an india-rubber substratum, and to dust on the plate.

Transparent spots may be met with when photographing near the sea. They are probably due to the chloride of sodium which is held in suspension in the air. They rarely occur if the plate has been thoroughly dried by artificial heat a short time before exposure.

Pinholes may be caused by the solution of silver added to the developer dissolving out iodide from the film. If the preservative be not well filtered, such defect may likewise occur.

Black stains.—When ferrous oxalate development is used, black stains sometimes occur through handling the plate with fingers not absolutely free from sodium hyposulphite.

CHAPTER XVII.

COLLODION EMULSION PROCESSES.

The dry-plate processes which are now to be described differ from all others previously described, in that the sensitive salts are formed in the collodion itself by direct application of a solution of silver nitrate, and not by immersing a film in the solution. The principal sensitive salt is invariably the bromide, though it is frequently recommended to use chloride and iodide with it. An emulsion is formed readily with the chloride and bromide, but with iodide greater difficulty is experienced.

Though an emulsion in collodion is easy to be made, there are certain details to be attended to in order to secure success, and these depend upon a knowledge of the theoretical principles involved in the formation of the photograph and its subsequent development, for which see Chapter IV.

Unwashed Collodion Emulsion Process.—The following will be found a good sample of an emulsion process. The plain collodion is made as follows :—

Alcohol	$2\frac{1}{2}$ ounces
Ether	5 ,,
Pyroxyline (prepared as given at page 31)...	75 grains

It is proposed that eventually 200 grains of zinc bromide shall be dissolved in the collodion, or combined with silver nitrate in excess.

Two hundred grains of the zinc salt are weighed out, dissolved in the smallest quantity possible of alcohol, and 4 or 5 drops of concentrated nitric acid are added to it in order to render any oxide or other impurity that may be present innocuous. This is then added to half the above collodion. We next require 300 grains of silver nitrate to saturate the zinc bromide, and to allow three grains in excess for each ounce of the concentrated collodion. As this will probably be about 11 ounces by the time the additions are made, 330 grains of silver nitrate (which has previously been pounded up in an agate mortar, or the crystals of which have been crushed with a glass stopper on a thick glass plate) are weighed out. This amount is then placed in a large test-tube, with 2 dr. of water, and warmed; a perfect solution ought to result. In another test-tube 1½ oz. of alcohol (·805) are boiled, and poured upon the dissolved silver. The two fluids may not mix at first, but by pouring them from one test-tube to another this is readily accomplished. This is added to the other half of the above quantity of collodion. Into this silver collodion the bromized collodion is added drop by drop with much shaking, or the silver collodion may be placed in a jar, and a stirring-rod used. In case this plan is adopted, the bottle containing the bromized collodion is taken in the left hand, and the stirring-rod in the right, and the bromide solution is poured, drop by drop, into the silver collodion, which is kept in brisk agitation by the glass rod. If the above details have been carefully carried out, the colour of a candle or gas-flame, when viewed through the liquid which runs down the inside of the glass jar after agitation, should appear of a deep orange approaching to a ruby tint. It must here be noted that with some pyroxyline it is absolutely impossible to obtain this ruby tint, no matter how carefully the mixing is done. With an unsuitable cotton it often assumes a grey or even blue form. The film in this case is often horny, and very transparent. When in the ruby condition, it may be judged that it has been rightly prepared. With the glass rod a drop or two of the emulsion should be dropped on to small strips of glass, and examined by daylight for structure, &c. When viewed through a window, the principal part of the light transmitted should be orange. A little potassium *chromate* should be dropped on to the emulsion on the plate, and a bright red colour will show that the silver is in excess, which is what is required in our case. If this colouration be absent, it will indicate that the soluble bromide is in excess, which, in some modifications of the same process, is what may be desired. The emulsion must next be decanted off into a bottle capable of containing at least double the amount of fluid—that is, at least twenty ounces—

and made up with equal parts of ether (·720) and alcohol (·805) to 15 ounces—and it should then be shaken for ten minutes. It may now be put on one side for from sixteen to twenty-four hours, when it will be ready for coating plates.

The reason of keeping it is to produce a creamy film, dense and sensitive. If used at once, the film would be apt to be insensitive, and be unsatisfactory. If kept longer than the above time, the bromide seems to change in character again, and to become less dense and less sensitive. The addition of a little soluble bromide (say 20 grains to the above quantity), and then 30 grains of silver nitrate, both in alcohol, will restore its sensitiveness.

The plate having been coated with a substratum or edged, the collodion (which should have been shaken about half-an-hour before it is to be used) is poured on it as collodion is in the wet process, and, when set, immersed in a dish of distilled or rain water. When all greasiness has disappeared, it is flooded with any of the preservatives given for dry plates prepared with the bath. Canon Beechey recommends the plate to be immersed in a dish containing beer to which one grain per ounce of pyrogallic acid has been added. The drying is conducted in the usual manner. The exposure may be taken to be about the same as that necessary to be given to a gum-gallic film. Between exposure and development the plates will keep fairly for a week, but after that seem to lose detail, and appear under-exposed. The alkaline developer (pages 100 and 101) is used for developing these plates, and the instructions given should be minutely followed.

Should the preservative on the plate be soluble in alcohol, then that solvent should first be applied to the plate (edged round with india-rubber if necessary), and then be washed till all the alcohol has been removed. It is very convenient to develop these plates on a levelling stand, in which case an india-rubber edging given to the film is a great help to keeping the solution on the plates.

Sufficient intensity is not always gained by alkaline development, but the plates also may be developed with the ferrous-oxalate developer (page 101), by which a greater density can often be obtained (see, also, page 126). If still deficient, the ordinary intensifier (page 48) should be applied afterwards. It is not always easy to secure sufficient density with emulsion plates, even by the application of silver and pyrogallic acid. In this case, after fixing, the image may be converted into iodide of silver by the iodine solution (page 49), be washed, flooded with a weak solution of silver, be exposed momentarily to light, and be then intensified by iron or pyrogallic acid (page 48).

The plates are fixed with potassium cyanide or sodium hyposulphite (see page 52).

If it be desired to make an emulsion with excess of bromide, the silver employed should be reduced to 280 grains, and the above directions followed, omitting the nitric acid from the zinc bromide.

Washed Emulsion Process.—When to a soluble bromide in collodion silver nitrate has been added, and an emulsion of silver bromide formed, there remains, as the result of the reaction, nitrate held in solution, or perhaps in minute suspension.* If the emulsified collodion were applied to a plate, and allowed to dry in this state, there would be a crystallization of these nitrates, and unless they were removed the film would be in an unsatisfactory state for developing the image. Washing the film, of course, effects this; but it is more convenient to wash the emulsion itself.

To make such an emulsion, the formula given in the last chapter may be adopted. The extra solvents should not be added (see page 121, line 1). After it has ripened for from sixteen to twenty-four hours, the next step is—

Evaporating the Solvents.—An emulsion generally may be prepared in the afternoon of one day, well shaken before leaving the laboratory, and on the next day, about noon, the emulsion will be ready for drying. The mode adopted by the writer is as follows:—The emulsion is poured out into a flat dish, to a depth of a quarter of an inch, and placed in a dark room, the temperature of the latter being raised, if possible, to 70°. For every ten ounces of emulsion made, a porcelain dish about 14 by 12, by three-quarters of an inch deep, is required.

After a short interval it will be found that a skin forms on the surface of the collodion; this is broken through with a glass-rod, and a fresh liquid surface given to it. Every half hour the whole of the emulsion is thoroughly well stirred up, till it begins to break into lumps, when it can be left a short time, for the solvents still further to evaporate. It is ready for the first

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* Some few nitrates are soluble in alcohol.

washing when the lumps require a little force to break them up —in other words, when they are about the same consistency as a collodion film before dipping into the bath. The mass is then removed to a glass beaker, and covered with distilled water. At this point we have a good test as to whether the evaporation of the solvents has been continued far enough. If evaporation have not been continued far enough, there is a tendency for the cotton to be little changed in quality. If only a few of the lumps rise to the surface, the evaporation has been sufficient; if, on the other hand, the majority float on the surface of the water, it has not been continued long enough. The reason of this tendency of the lumps to rise to the surface is due to the light specific gravity of the ether and alcohol, which, even with the weight of the solid matter, is not sufficient to counterbalance the specific gravity of the water.

The foregoing is the simplest, but rather wasteful, method, and resort may be had to a still* by which to evaporate and collect the solvents; but in this case the nitric acid must be omitted if the solvents are to be used again, and the elimination of fog-producing products take place in the first wash water.

For the above quantity of emulsion, 1 dr. of nitric acid, which will be ample to secure freedom from fog, should be added to the wash water. After a couple of hours the true washing may commence.

Another plan is to wash in a couple of changes of water, and then to add hydrochloric acid (half an ounce of hydrochloric acid to 10 ounces of water) to the next wash water, and again wash. This is an effectual plan of eliminating fog, and the pyroxyline is not altered in quality by this acid.

The emulsion may be placed in a jar or jam pot, and be covered with water where it can stand two or three hours in the dark without detriment, when it should be changed. The way in which the washing can be economically effected, as regards time, is as follows:—A piece of coarse calico which has previously been washed in carbonate of soda, and then well rinsed and dried, is spread over the top of a second glass jar or large jam pot, and the conrents of the first thrown on to it. The calico acts as a strainer, and the solid pellicle is left on it. The calico is next taken up by the sides, and the contents are twisted up

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* See "Emulsion Processes in Photography," page 232.

in it, and as much as possible of the liquid then wrung out. The calico is untwisted, and a bag formed (by tying up the ends) to hold the emulsion, which is shaken up and immersed in fresh distilled water. After a quarter of an hour the wringing operations are again proceeded with, and this process repeated three or four times. The expelled water should now be tested for free silver nitrate by a drop of hydrochloric acid. If it give more than a slight milkiness, such as is produced by adding silver nitrate to water containing a grain of common salt to the gallon, it must be washed till this maximum is attained.

Preparing the Pellicle for Re-emulsifying.—A very important part of emulsion making is now to be touched upon, viz., getting rid of the water held in the pellicular mass.

To commence with, as much water as possible should be squeezed out, and then we may proceed in one of these ways.

1st. We may lay it out flat on a piece of blotting-paper, and allow it to dry spontaneously. 2nd. We may put it in a flat porcelain dish, and place it in a water bath, the temperature of which can never exceed 212°, and thus all moisture may be got rid of. In this last proceeding, the very greatest care is necessary, as the emulsion is apt to become very hard indeed, so much so as to be scarcely soluble; in addition to which, it is often apt to blacken spontaneously. 3rd. This method is one which we can confidently recommend for washed emulsion, being very simple, and absolutely improving its qualities when re-dissolved. This is simply to cover it with rectified spirit (·820) after as much water as possible has been squeezed out. In an hour's time the excess is drained off, and the pellicle is squeezed in the cotton rag as before. It is then once more covered with the spirit, and left for half an hour, when, after draining away the superfluous spirit, it is ready for re-emulsifying. If it be desired to keep the pellicle in a solid state, it will only be necessary to expose it to the air for a few hours, when it will be found quite dry.

It is instructive to examine the washings from the spirit. It will be found that there is a certain small quantity of silver bromide in suspension, which can be filtered out. If the spirit be distilled over, a semi-opaque liquid residue will be left, having a very high boiling point, a strong and disagreeable smell, and containing some organic salt of silver, which discolours in the light. It may be said that this organic compound is necessary for density of image, but a trial of the emulsion washed in this way will prove the contrary; in addition to which it will be found much freer from spots than that washed and dried by the first two methods indicated above.

There are some pyroxylines which it would be dangerous to treat in this manner, since they are soluble, to a certain extent, in absolute alcohol; but it seems to the writer that any such pyroxylines are detrimental when washed collodio-bromide emulsion is in question. If they are employed, the first or second method must be adopted.

The dried (or moist with alcohol) pellicle has next to be dissolved in its proper proportions of solvents, which are about 6 grains of pyroxyline to every ounce of the two when mixed. It is better to make it up first to the strength of 9 grains of pyroxyline, and then to add the remaining solvents, since the colour of the emulsion seems to be better when a greater degree of viscidity is present, when the pellicle begins dissolving. In two or three hours the whole of the silver bromide should be in suspension. It will be found, however, that there is an improvement in the quality of the film after the lapse of a couple of days, or even more. A plate should be tried before diluting down the collodion with more ether and alcohol, in order to test its flowing qualities, and to note the opacity of the film.

In our own experience we like a plate through which, when freshly coated, the light from a gas jet can just be distinguished, but which, when dried, is very nearly opaque. In this condition the film is tough, seldom requires backing, and is always capable of giving sufficient density by alkaline development alone.

The plate can now be simply coated with the emulsion, and when dried is ready for use. As the result of hundreds of experiments, the writer has unwillingly come to the conclusion that a washed emulsion without a preservative of some kind is a dangerous process in which to place absolute trust. Films which would give perfect negatives, free from those spots which refuse to develop, may, after keeping some time, show them in perfection, spoiling every picture taken upon them.

The reader may turn back to dry plate processes with the bath, and employ any of the preservatives there mentioned. The following is one recommended by Colonel Stuart Wortley:—

No. 1.—Salycine, enough to make a saturated solution in distilled water.

No. 2.—	Tannin	60 grains
	Distilled water	1 ounce

No. 3.—Gallic acid	48 grains
Alcohol	1 ounce

To make the preservative, take of—

No. 1	2 ounces
No. 2	1 ounce
No. 3	½ ,,
Sugar	40 grains
Water	7 ounces

This preservative may be used over and over again with occasional filtering. The plates are best immersed in it.

A substratum will in many cases be required, though often by first washing off the preservative, then allowing the film to dry, and flooding with alcohol, and again washing, and then proceeding to development by the alkaline or ferrous-oxalate developers (pages 100 and 101), any tendency to blister, or unequal development of the image, will be prevented. Those who have not the time to adopt this method must use the substratum if a gum or albumen preservative be used, an edging being of but little use, and unless the preservative be soluble in alcohol. The method of applying alkaline development has already been given at page 101. The mode of developing with ferrous oxalate is as follows:—If the saturated solution of the developer (made by dissolving ferrous oxalate in a saturated solution of potassium oxalate) be used, we dilute it with half its bulk of water, and add to every ounce 1 drachm of a solution of potassium bromide in water (20 grains to 1 ounce), and apply this to the film after washing, as described above. If the image appears slowly, we add half the original quantity of the ferrous oxalate undiluted, and then, if the exposure be anywhere near correct, this will bring up the requisite density. Should more density be required, we intensify as given at page 48.

Should the image refuse to come out even with the stronger developer, one drop of a 10 per cent. solution of sodium hyposulphite to each ounce of developer will have an accelerating effect (see page 11).

The exposure required for this development seems to be about two-thirds of that required for the alkaline developer given above, and is, therefore, a decided gain to the photographer.

There is a great charm in this developer, the plates gaining in tensity steadily, and without any tendency of being overdone; an d the negatives give brilliant prints.

A modification of the ferrous oxalate developer, which, for sake of perspicuity, the writer calls citro-ferrous oxalate (see page 103), is also applicable for development. It works rather slower, but can be used without the addition of *any bromide.* The solution is mixed with an equal bulk of water, and the development modified and carried on as above described for the ferrous oxalate. The sodium hyposulphite may be used with it as with the ferrous oxalate developer.

It may be asked, what advantage a washed emulsion has over an unwashed one, since with both a preservative is recommended? It is this. If an unwashed emulsion in which there is any large excess of silver present be kept longer than just to ripen it, it becomes transparent, and loses all its "creaminess," and then loses its sensitiveness in a great measure. When an emulsion is washed, it remains in the same state of sensitiveness from year's end to year's end, supposing a suitable and properly-washed cotton to have been used.

Besides the defects noticed, there are a few others which must be alluded to.

Crape markings in the film are usually due to the solvents of the emulsion being too aqueous; or they may be due to the emulsion not having been shaken up shortly before being used; or to the bromide being too coarse.

Thin transparent films with washed emulsion are usually due to the last two causes.

The emulsion refusing to flow properly is due to deficiency of solvents. This is frequently met with if the same emulsion be used for many plates. It should be diluted down with 1 part of alcohol (·812) to 2 of ether (·720).

When the film tends to peel of the plate, the pyroxyline is probably of too contractile and horny a nature, in which case the proper treatment is to mix it with an emulsion made with one of a more powdery character, or to mix $\frac{1}{20}$ part of a saturated solution of gum guiacum in alcohol with it.

The cause of fog has been pointed out in Chapter IV. To eliminate it in a washed emulsion, the careful addition of a few drops of a dilute solution of iodine in alcohol will prove effective. With such an emulsion, when used with a preservative, a dip in a 10 per cent. solution of hydrochloric acid in water will eliminate all fog. In an unwashed emulsion the addition of nitric acid will effect a cure.

CHAPTER XVIII.

PREPARATION OF GELATINE EMULSION.

We next come to the gelatine emulsion process, in which the silver salts are suspended in gelatine instead of collodion. These claim attention on account of their great sensitiveness.

Gelatine.—Gelatine is ordinarily hygroscopic, and contains, at ordinary temperatures, from fifteen to twenty per cent. of water. In cold water it swells up, and absorbs from five to ten times its weight of water; good gelatine will absorb enough cold water to dissolve it, if the temperature is raised above 90°. Very weak solutions of gelatine will solidify to a jelly when cold, sometimes when only one per cent. is present; but long boiling destroys, to a great extent, this power of setting.

Gelatine will keep indefinitely in a dry state; but in contact with water it soon putrefies, becoming first acid, and then strongly alkaline, and giving off ammonia; at a temperature of 100°, decomposition will often begin in twenty-four hours. Hence it is evident that long boiling, besides destroying its power of setting, also tends to produce decomposition of gelatine.

A gelatine which by itself is soluble at a low temperature, is unfitted for gelatine emulsions, particularly if the temperature at which it is prepared is at all high, since it would then not set. An example of this is Nelson's No. 1 gelatine. In warm weather it will dissolve in the water at the temperature of the room in which it is soaked. Swiss gelatine or Heinrich's is the other extreme; they will be found not to melt till the vessel has been plunged into water about 110°. As might be expected, as regards setting, these two gelatines are the most opposite. At a temperature of about 70, No. 1 will scarcely set at all, whereas the two latter will set in a short time.

An important test is for acidity or alkalinity. For our own part we strongly recommend a gelatine which is slightly acid where an emulsion is to be boiled, and if not in this state, we acidify the gelatine solution. When the ammonia process (see page 132) is used, the condition of the gelatine does not matter so much. In some gelatines, the acidity (due to the hydrochloric acid used in its manufacture) can be tasted by applying a piece to the tongue. A hard gelatine can be at once identified, when it is set, after dissolving in the water, which it will absorb.

To select suitable gelatine for an emulsion, we recommend that a small batch of emulsion be made with the specimens proposed to use, and that a few plates not smaller than 7 by 5 be coated and tested before taking it into use for larger quantities.

In our own practice we like to use either a gelatine of medium hardness, or else a mixture of two kinds of gelatine—one hard and one soft—and the proportions of these we vary according to the weather. As a rule, we like one part of hard to three parts of soft, as it will then set with ease at a moderate temperature, and be hard enough to resist the tendency to frill; and is at the same time readily permeable by the developing solutions.

One fact must also be recollected, that frequent re-heating of gelatine speedily detracts from its setting powers, and that if too little water be added to it in mixing, the film has a great tendency to become leathery, more particularly if a little chrome alum has been added to it to prevent frilling. A judicious mixture of alcohol to a gelatine solution increases permeability, and should not be neglected. The use of a sufficient quantity of water is, however, the great desideratum, and should be carefully attended to, the quantity, of course, depending on the temperature at which the plates have to be prepared; thus, in winter, more water should be used than in summer. A very horny, glossy film is said to be objectionable in many ways,* and a matt surface for the plates should be generally aimed at. This depends almost entirely on the gelatine that is used, unless it

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* In some cases we have found a glossy film the best. It is slower in development, since gloss means that the bromide of silver is covered by a layer of gelatine. A matt surface means that the bromide has but a very slight covering of gelatine.

be modified by additions, such as glycerine, to which we may at once say we object, on account of its affinity for water.

We propose to give a detailed account of two methods of making an emulsion in weather of ordinary temperatures, say up to 65° Fah.,* which may be taken as a pattern on which to form others by any other formula. Both will be found to be exquisitely sensitive to the blue rays, and very slightly to the orange, which latter quality means that the development and preparation of the plates can be conducted in a room with any quantity of red light. In the formula we have given iodide, as we consider it as much a sheet-anchor for the production of brilliant negatives, in the same way that a trace of bromide is to the wet collodion process. Those who choose to omit it, can do so by omitting an equal weight of silver nitrate when the potassium salt is used. We prefer the first process ourselves, finding it more sensitive. The light to be used in its preparation may be gathered from Chapter I. Also see chapter on the Dark Room.

By both plans a modification of the silver bromide in regard to its molecular state is effected, and it is this which partially gives such extreme rapidity. One cause of the rapidity undoubtedly is that the gelatine is a physical restrainer of a developer, and hence a stronger method of development can be employed without causing fog, which is not the case even with the same modification of bromide when held in a collodion film.

The reader must remember that tricks cannot be played with the light of the dark room, such as are admissible when the comparatively slow wet process is used. Thus he should see that no light of the wrong colour penetrates at any place; he should pay particular attention, for instance, to the chinks under the door and in the sashes of the window-frame. When he has come to the conclusion that no daylight is entering his room, he may think about preparing the emulsion. First of all, he must make a few preparations. The jar or bottle in which the emulsion has to be mixed must be scrupulously clean. There should be no patches of old emulsion left on it. If a glazed jar be used, it should be seen that the glaze is not cracked in any way, since fog may be expected if it be. For dissolving the gelatine, &c., we like to use glass beakers with a lip, since they

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* For other modifications see "Emulsion Processes in Photography," Piper and Carter, 5, Castle Street, Holborn, E.C.

are handy for pouring. These also must be scrupulously clean and dry. The scales in which the weighing has to take place should be examined for dirt (chemical or otherwise), and a few circular filter papers on which to weigh the materials should be at hand. Weighing should never be done* without a filter paper of equal size and weight being placed in each pan of the scale. A saucepan of hot water should be ready for the beakers, &c., in which the different materials have to be dissolved, and care should be taken that it is not too full. It need scarcely be said that all weighing can be done in ordinary light. To commence operations, the following may be weighed out separately and placed on clean† paper after weighing, it being supposed that a dozen or a few more whole-plates are required.

1.—Potassium iodide	5	grains
2.—Potassium bromide	135	,,
3.—Nelson's No. 1 photographic gelatine ...	30	,,
4.—Silver nitrate	175	,,
5.—Autotype‡ and No. 1 gelatine (equal parts)	240	,,

Nos. 3 and 5 are rapidly covered with water, shaken or stirred in it a few seconds, and the water poured off as quickly as possible. This gets rid of any adherent dust on them. Nos. 1 and 2 are then dissolved in 1 drachm and 1½ ounces of water, respectively. To the solution of bromide (No. 2) 1 minim of strong hydrochloric acid is added, together with sufficient of an iodine in alcohol solution to make it a deep sherry colour. No. 3 is swelled for ten minutes in 1 ounce of water, and then dissolved by heat; No. 4 is dissolved in ½ ounce of water and heated to about 120° Fahr.

In the *dark room* No. 3 is added to No. 4, and shaken up in a bottle till a perfect mixture is secured. Three-quarters of the solution containing No. 2 is then dropped in, little by little, and shaken up after each addition; and then the solution of No. 1 is added to the remaining ¼ of the solution of No. 2. The mixture

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* Especially on brass scale pans.

† Any contamination by dirt of any description, and particularly that to be found in a photographer's workroom, is almost sure to spoil the emulsion, or at all events its sensitiveness, and to cause endless evils. Hence *clean* paper should be used, and the chemicals should not be left on the benches or table in contact with the wood.

‡ In case this cannot be procured, mix 1 part of Nelson's No. 1 gelatine with 1 part of some hard kind, such as Heinrich's or Simeon's Swiss.

is then added as before. The emulsion should appear of a ruby colour when a thin film of the liquid emulsion is examined by a gas light.

Boiling the Emulsion.—A saucepan of sufficient size to hold the bottle* must be procured, and filled with water to a convenient height, and a flame, such as a gas-burner, placed beneath it.† After the water has been brought to boiling point, the emulsion is kept boiling for forty-five minutes; it being shaken at intervals (say once every ten minutes) for half a minute or so. A thick cloth tied round the hand prevents any scalding. The boiling, by-the-bye, should take place without the cork being left in the bottle, for if it remain in it would be blown out by the force of the steam. A cork with a slot cut in it is, however, not open to objection. The emulsion, when examined by gas-light, should still appear yellow, but when held up so as to light from the sky it should be of a violet tint. It saves trouble if the boiling continues till this is the case.

Cooling the Emulsion.—After the proper time of boiling, the saucepan is removed. The gelatine No. 5 should, in the interval, be placed in a pot with 2 ounces of cold water and allowed to swell. After this it is melted at a temperature of about 100° by immersing the pot or flask in hot water, and added to the solution in the bottle. *Both the emulsion—and also the dissolved gelatine*—should be cooled to about 70° to 80° F. by allowing water from the tap to run over the jars before the addition is made.

Preparation of an Emulsion with Ammonia.—Instead of boiling, the plan may be adopted of emulsifying in the presence of ammonia, a plan originally due to Dr. Van Monckhoven, but more recently experimented with by Dr. Eder. The safest plan we know of, however, is that practised by Mr. A. Cowan. The quantities of material may be taken from page 131.

A. No. 1 is dissolved in 1 drachm of water. No acid or iodine is used.

B. No. 2 in 1½ ounces of water. No. 3 is soaked and

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* To prevent bumping and breaking the bottle, we place half-a-dozen folds of blotting-paper at the bottom of the saucepan.

† We prefer boiling the emulsion in a glass flask to anything else, but a bottle answers if the temperature is *gradually* raised; a *well-glazed* earthenware bottle will also answer the purpose.

swollen, and dissolved in the same water in which No. 2 is dissolved.

C. No 4 is dissolved in 1 ounce of cold water, and ammonia ·880, diluted to half its strength, is added drop by drop to it till the oxide of silver first precipitated is first dissolved.

D. No. 5 is dissolved in 2 ounces of water.

B is allowed to cool down to about 70°, when C is added to it, drop by drop, with much stirring or shaking. When all is added, A is next dropped in. To the emulsion may at once be added D, and be washed, when it will form a moderately rapid emulsion; or it may be put aside for eighteen to twenty-four hours, when it will become excessively rapid, and then D may be added to it as in the boiling process (see *ante*). The emulsion takes a grey appearance by transmitted light. It will be seen that this emulsification takes place with cool solutions. The gelatine is less liable to be acted upon by the ammonia by this procedure. In warm weather it is recommended that D be added at once to the emulsion and left for eighteen hours, otherwise the emulsion is apt to become granular.

Setting and Washing the Emulsion.—By both methods, after a good mixing by shaking of the emulsified bromide and the extra gelatine, the froth is left to subside, and the emulsion is poured out into a flat porcelain dish,* and allowed to rest. The time which it will take will vary according to the temperature of the surrounding air, but a couple of hours is generally amply sufficient, and often a very much less time will suffice.† After a proper consistency is obtained (such consistency being that the gelatine should not tear with a moderate pressure of the finger), the emulsion is carefully scraped off the bottom of the dish with a strip of *clean* glass, and transferred to a piece of mosquito netting—such as is used for mosquito curtains—or to coarse canvas,‡ such as is used for wool work (fig. 19, p. 134), which has been previously boiled in hot water to get rid of any

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* When the emulsion is to be "squeezed," if it is set in a jam pot, it turns out in a more convenient shape. In a dish, however, it sets more rapidly, since a greater surface is exposed to the cool air.

† In very hot weather, if the dish be stood in iced water, no difficulty in setting will be found. It is absolutely necessary that the set emulsion should be firm, as if not it will take up much water in washing.

‡ The canvas should be as coarse as can be obtained, since, if fine, the emulsion, after washing, has too much water *adhering* to it.

grease or dirt. The emulsion is then twisted up in this, and, by a gentle pressure, squeezed through the interstices, the ball of emulsion being absolutely below the surface of the water into which it is forced. The water causes the threads of gelatine to remain tolerably separate, and, as it passes through the liquid, most of the soluble salts are at once extracted.

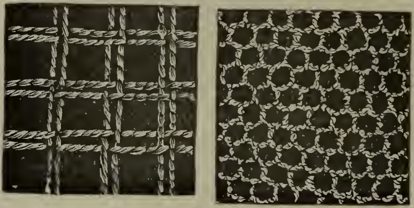

Fig. 19.

When all is squeezed through, the particles of gelatine may again be transferred to the canvas, and after stretching it loosely over the mouth of the jar, the emulsion may be doused with water from the tap or from a water jug, and then left to soak for half an hour. After this the emulsion should again be squeezed through the canvas, and the same operation repeated, thus exposing fresh surfaces of gelatine to the action of water. After another sluicing with water the emulsion may be considered as washed, though, to make assurance doubly sure, the gelatine may be left at the bottom of the jar, and the water changed two or three times.

This method of washing, the writer considers superior to that given below. Two squeezes, it is believed, are equal to twenty-four hours' such washing. Gelatine is hard to permeate, and, being a colloidal body, the crystalline salt has hard work to get through when the emulsion is not finely broken up.

Alternative Mode of Washing.—A plan adopted by Mr. England is, after the gelatine is set in a dish, to score it over with the prongs of a silver fork, so breaking it up into fine strips; he then scrapes it off the bottom of the dish, and transfers it to a jar in which a stream of water is kept running for twelve hours; or it may be washed by changes of water, the change being made at not less than half-an-hour's interval.

Dr. Eder, to whose careful researches photographers are much indebted, finds by absolute analysis that emulsions passed through fine canvas are sufficiently washed in about thirty-five minutes in running water, and nearly in the same time in standing water; through coarse meshed canvas in one and a-quarter hours in running water, and in a much longer time in standing water. When cut in strips, it is probable that twelve to twenty-four hours are necessary to free it sufficiently from the soluble salts, in order for it to have a maximum sensitiveness.

Draining the Emulsion.—When the emulsion is considered to be properly washed, it is then drained. This the writer generally does over the canvas, though some recommend a hair-sieve, but it does not appear that there is much advantage to be derived from its use. The great point in either case is to drain long enough. A couple of hours is sufficient time, and then the emulsion is ready for melting.

It should be noted that before re-dissolving the emulsion, it should be firm and free from all sloppiness (if such an expression may be used), and it will sometimes happen that no amount of draining over a hair-seive or canvas will render the emulsion sufficiently free from water to set well when dissolved up. We have found that by pouring a couple of ounces of alcohol through a 10-oz. batch of emulsion when draining, the excess of water is taken up, and it becomes fairly firm. One dose of alcohol should effect this, and, if not one, two will. The alcohol may be saved if required. In case this artifice be resorted to, none of the alcohol given below should be added to the emulsion, when it is re-dissolved. Emulsion that is cut up into shreds is much more easily drained than that which is squeezed through canvas. It is not that the gelatine takes up more water, but that the water clings mechanically to the small particles.

Dissolving the Emulsion.— After draining, the emulsion should be transferred to a clean jar or jam-pot, and then placed in boiling water till all the gelatine is thoroughly dissolved. A temperature of 120° or more may be given it with advantage. The emulsion, when all additions are made, will be about 10 ounces. The addition of ½ grain of chrome alum is sometimes to be recommended. This should be dissolved in 1 drachm of water, and added with stirring; 4 drachms of absolute alcohol are next to be added in the same way. If extreme rapidity* be required,

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* In this case, chrome alum should *not* be added to the emulsion, as the ammonia causes a precipitate, to which spots on development can often be traced.

the following procedure may be adopted:—To every ounce of emulsion add one drop of strong ammonia (·880), after diluting with ten times its bulk of water. Keep the emulsion liquid, and at a temperature of 90° F., for a couple of hours, and then allow it to set. In twelve hours it is ready for filtering.

Filtering the Emulsion.—This operation may be carried out in various ways. The writer now uses three folds of swandown calico which has previously been well boiled and washed. This is allowed to rest loosely in a funnel, and the emulsion filters slowly through it, all coarse particles being left behind.* Wet chamois leather is also often used instead of the swansdown calico. A small plug of washed wool is used by many, and answers well. It is preferable to filter into a flask, as it will bear heat, though an ordinary medicine bottle will answer if the flask be not at hand. The bottle or flask is again placed in water at a temperature of 120°, and the next operation is to coat the plates.

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* There are several mechanical aids to filtering, which can be procured from dealers.

CHAPTER XIX.

PREPARATION OF THE PLATES.

Cleaning the Plates.—To clean the plates it is our own practice to immerse them in nitric acid and water (1 to 10), then to wash, and next to rub them over with a 10 per cent. weak solution of caustic potash or soda* and a little methylated spirit. After a wash under the tap the water should flow quite evenly from off them, when, after a rinse with distilled water, they may be set up to dry, which they will do very rapidly if allowed to stand on clean blotting-paper. Polishing a plate is a mistake; it only encourages the formation of blisters, as it prevents the adhesion of the film to the glass. Avoid French chalk, or anything but pure water, and then one of the causes of frilling and blistering will have been eradicated. The plates having been cleaned as above, they are brought into the dark-room, which should, if possible, be kept at a temperature between 50° and 65°, as this is the heat which is most convenient at which to coat the plates and to ensure setting.

Substrata.—If it be determined to use substrata to avoid frilling (for which it is a cure) the following formulæ may be used:—

White of egg	1 ounce
Water	20 ounces
Methylated spirit	1 ounce
Carbolic acid	20 drops

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* A bit of the alkali the size of a walnut, and ½ an ounce of methylated spirit, is sufficient for 4½ ounces of water.

The carbolic acid is added with stirring to the spirit, and then the mixture poured into the albumen and water, which has been previously mixed.

The one we prefer, however, is made with silicate (page 90).

Levelling Shelf.—When coated, the plates have to be perfectly level, in order to set. If the drying cupboard has the arrangement of level shelves shown at page 96, nothing further is needed; but if not, a special shelf must be laid.

In our own practice we have a piece of thick plate glass about 3 feet long by 1 foot broad, and $\frac{3}{4}$-inch thick; but a slab of slate may be readily obtained and ground true. Slate is very much cheaper than glass. The levelling is done by means of three mahogany wedges and an ordinary spirit level, or levelling screws may be used

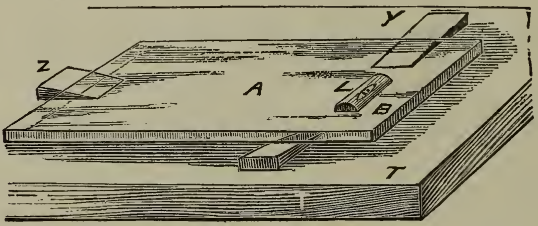

Fig. 20.

The level L is placed first across the plate, and the two wedges X and Y are altered till the bubble of the level is central; the level is then turned lengthways along the plate, and the bubble caused to occupy its proper position by shifting Z, not touching X or Y. This should cause the plate, if true, to be accurately level; but it is as well to repeat the operation. A couple of supplementary wedges are sometimes useful if the shelf "spring" at all. If the drying cupboard is provided with level shelves or levelling screws (see page 96) this large levelling shelf may be done away with.

Coating the Plate.—The shelf being level, a plate is taken on a pneumatic holder, or held upon the tips of the fingers. We will suppose it to be a $6\frac{1}{2}$ by $8\frac{1}{2}$ plate that is to be coated. About 2 ounces of emulsion are poured into a warmed measure, *taking care that no bubbles are formed* (which can be secured by pouring out the emulsion against the side of the measure), and a pool of gelatine is made at the top of the plate. It is then, by careful pouring, made to fill up the centre of the plate, and flow to the right-hand top corner, next to the left-hand top corner, then to the left-hand bottom corner, and, finally, to the right-hand bottom corner, where it can be partially poured back into the measure. The amount used should be noted; about 80 oz. should coat 12 doz. 8½ by 6½ plates. The plate is then detached from the pneumatic holder (if used), held by the two corners of the diagonal, and very quietly rocked till an even coating is seen to be secured. It is then cautiously slipped on the level shelf, and left to set. Another plate is taken and similarly treated; and when the shelf is full, the emulsion on the first plate will have set, and it must be removed to the drying-rack (page 97), and thence to the cupboard. When the drying cupboard shelves are levelled, the coated plates are at once placed on them. Against one thing we would earnestly warn tyros, viz., not to mix hot emulsion with the cold emulsion already in the pouring-cup, as it is apt to give scum marks. The cooled emulsion should be returned to the flask, allowed to warm up, and then a fresh lot poured out as before into the measure.

There are other modes of coating the plate to which we may refer. After a central pool is formed on the plate as above, the emulsion may be guided by a glass rod along each edge, and thus the chance of spilling is lessened. For our own part, we think that this is not a good plan; first, because the glass rod is liable to collect dust, as it must be wiped between coating each plate; and secondly, if the central pool of emulsion be not spread out rapidly, coating marks are apt to be seen on the finished negative.

Another plan which is advocated is to brush the plate over with a very thin film of emulsion by means of a wide badger-hair brush (kept in a small quantity of warm liquid emulsion), and then to pour over the plate the full quantity. This is not a bad plan if the brush be kept clean. When the emulsion will not flow, our preference is to use a squeegee rather larger than the plate, one side of which is covered with swansdown calico. This should be *slightly* moistened in water (warmed if in cold weather), and dragged along the surface of the plate, and then the emulsion poured on immediately afterwards. With plates to which any substratum is given, some such artifice is almost necessary, as the emulsion often refuses to flow.

Drying the Plates.—The temperature of the cupboard should be kept as even as possible, sudden changes being detrimental—producing markings. Opening the drying cupboard door before the plates are dry, when once the gas has been turned on, is a mistake; the plates should be left until it is judged they are quite dry. Very quick drying is also a mistake, as the different layers of the film get an uneven strain which eventuates in frilling. Twelve hours is about the minimum time which we can recommend, unless drying by alcohol is resorted to. The temperature should, if possible, not exceed 80° F., and the gas must be regulated accordingly. Drying by alcohol is effected by placing each plate, *after thorough setting*, in a dish of methylated spirit free from resinous matter for ten minutes, when it will dry in an hour without difficulty.

In very hot weather there is sometimes a danger of the gelatine running from the plate in the drying cupboard. In such weather it is well to have a small gas jet in the gas pipe (fig. 15, p. 95), just above the level of the box. By this plan the air passing through the box remains at its normal temperature, the air being heated in outside tube above. This creates a sufficient draught.

Another drying-box is given in the chapter on the Heliotype Process, and in this form, by detaching inlet tube from the zinc pipe, cool air may be made to circulate.

CHAPTER XX.

EXPOSURE AND DEVELOPMENT OF GELATINE PLATES.

Perhaps the most difficult part of the gelatine process is to guage the right exposure to be given in the camera. The time during which the lens should be uncovered varies between the fiftieth part of a second and five to ten seconds; 1st, according to the sensitiveness of the plate; 2nd, according to the general light; 3rd, according to the nature of the view; and 4th, according to the available aperture of the lens. In order to ascertain the sensitiveness of the plate a very useful piece of apparatus is Warnerke's sensitometer, which can be obtained commercially. It consists of a piece of glass covered with squares of pigmented gelatine, each square having painted on it an opaque number. The light penetrating through one of these squares is about one-third less intense than the number immediately preceding it By exposing a plate behind such a sensitometer to a constant light, such as a phosphorescent tablet which is sent out with the instrument, or a candle which has burnt five minutes, and placed at a fixed distance from the apparatus during exposure, the relative rapidities of any plates may be ascertained. Plates prepared by the formula given in Chapter XVIII. should show from 18 to 25 according to the length of time during which the emulsion is boiled, and also according to the time it is kept after boiling.* A plate on which the last sensitometer number visible after development is 23, is very rapid, and should have ample density at the same time. When using a Dallmeyer rapid rectilinear

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* The sensitiveness increases nearly three times by keeping a couple of days before coating the plates.

lens with No. 5 stop, which has an aperture of about one-fortieth of the focal length, such a plate exposed on a landscape in spring time when the light is good should be impressed with a fully developed image in half a second if the view is an open one with trees not too close. The same plate with the largest stop should give an equally well-exposed picture in the $\frac{1}{25}$ part of a second.

It need scarcely be said that the plate when prepared should never see any light which is the least injurious to it, and care should be taken, when placing it in the slide, to use light such as given in the chapter on the Dark Room, or else to use a proper lantern in a darkened room. The slides should close perfectly, and the hinges of the front should be of leather, as introduced by Meagher. This renders the slide secure in this respect. It is a good plan to follow the practice of Mr. England, and to have the slides in little sheaths of cardboard, into which they are slipped when filled, and not *in situ* in the camera. When in the camera the slide should be covered with the focussing cloth, nd the front withdrawn whilst beneath it. This prevents the access of any stray light to the plate.

The lens should also be examined to see that no reflected light enters through the aperture made for the diaphragms. This can be done by capping the lens, opening the focussing screen, and placing the head beneath the focussing cloth. A piece of black velvet with an elastic band attached may be used to cover over the aperture should any light appear.

Another point to see to is that light coming through the lens is not reflected on to the plate from the inside of the camera. This is most likely to occur when a lens is used which will cover a larger plate than that which the camera is made to take. In such a case a diaphragm placed behind the lens of such a size and shape that the image will just cover the plate is effective. The inside of the camera should be well blackened, but the black should be dead and not shiny.

In fine, too much care cannot be taken to avoid the slightest chance of any light striking any part of the plate except through the proper aperture of the lens. The same precautions should be taken after exposure as well. Remember it is dangerous to expose a slide to the full effect of sunlight. Give a full exposure, but not an excessive one. A plate can be controlled in development, if it has received two or six times too much exposure, with the emulsion given in Chapter XVIII., but more than this is almost uncontrollable. An under-exposed plate is useless. It will thus be seen that judgment and practice are required to secure good results, and an amateur should not be astonished if two out of three plates he exposes yield unprintable negatives until he has had practice in exposure.

Development of a gelatine plate is in reality an art and science combined. The art consists in getting proper gradation, and the science in mixing your solutions to obtain it. There are only two kinds of exposed plates which deserve attention at all—one when it is exactly timed rightly, and the other when it is over-exposed. An under-exposed picture should be washed off as quickly as possible, or framed for the benefit of beginners. Our own practice in developing is only to make up two solutions, one of bromide potassium, the other of ammonia, and to add dry pyrogallic acid to the measured quantities. The formula stands thus—

1.—Pyrogallic acid	3 grains
2.—Potassium bromide	10 ,,
Water	1 ounce
3.—Ammonia ·880	2 drachms
Water	18 ,,

The normal developer is made as follows—

No. 2.	1 drachm
No. 3.	1 ,,
1.—Pyrogallic acid	3 grains

Water to make up to 2 ounces.

To measure out the pyrogallic acid we use a strip of glass about ½-inch wide, and after one or two trials approximately three grains can be taken out. Some use a salt-spoon for the same purpose. If distilled water be used with the pyrogallic acid, it will only slightly discolour during development. The method of applying this developer is the same as that given below. The next developer meets with the approval of many.

The following solutions should be made up:—

*P.—Pyrogallic acid	50 grains
Sodium sulphite	150 ,,
Citric acid	10 ,,
Water	1 ounce

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* The sulphite should be first dissolved in the water, next the citric acid, and finally the pyrogallic acid.

B.—Potassium bromide	50 grains
Water	1 ounce
A.—Ammonia ·880	2 drachms
Water	2¼ ounces

These nearly correspond to 10 per cent. solutions.

The plate is developed by taking of the above—

P	20 minims
B	30 ,,
A	60 ,,
Water	2 ounces

We prefer, however, not to apply this strength at once. We should commence by taking—

A	10 minims
B	5 ,,
Water	2 ounces

and would allow the plate to soak in this solution for a minute. It will be noticed that the solution is weak. Into the cup there should be dropped the normal strength of pyrogallic acid suitable for the plate under development, which we have given as 20 minims. When the A and B are returned to the cup, the whole solution is poured over the plate, and the development watched. If the image begins to appear immediately, the developer is washed off and the plate rinsed, and into the cup are dropped 15 minims more of B and 20 of A; the image will now appear more gradually, and increase in density; 30 minims more of A and B may then be added, and it will be found that the negative will attain sufficient intensity. There should be no fogging of the plate if sufficient bromide be used; this is a case of over-exposure. If the image begins to appear in about ten to fifteen seconds, it may be presumed that the exposure has been correct, and then the full doses of the ammonia and bromide A and B may be at once added to the cup, the developer poured back, and used till sufficient density is obtained.

Should the image not appear for twenty seconds, the developer should be poured away, the plate rinsed, and be flooded with A 60 minims in 1 ounce of water, supposing this to be the strength of ammonia it will bear in the normal developer; and after a couple of minutes 20 minims of B and 20 of P should be dropped into the cup, and development be proceeded with. If the image appears in two or three seconds, and begins to get detail in ten, the action may be allowed to continue; if not, 30 more of A and 20 of P should be added. If this fails to bring out detail, the plate is hopelessly under-exposed, and no amount of forcing will make it yield a good negative.

Such are the outlines of development by the alkaline method applicable to the first developer given, as well as to that containing the sulphite. It will be seen that there is more than "rule-of-thumb" work in it. It requires an intelligent application of the known effects of the different ingredients composing the developer to make the best of a negative. There are innumerable changes to be rung on the three compounds, which make it all the more difficult to carry out properly.

Nelson's developer is made as follows:—

No. 1.

Pyrogallic acid	1 ounce
Methylated spirit	7 ounces
White sugar	1 ounce
Distilled water	3 ounces

No. 2.

Ammonia ·880	4 ounces
Ammonium bromide	1 ounce
White sugar	½ ,,
Water	2 ounces

Use 40 minims of No. 1, and from 30 to 40 minims of No. 2, mixed in 2 ounces of water.

Messrs. Wratten and Wainwright, with their ordinary or slower plates, recommend the following:—

I.—Pyrogallic acid...	2 grains
Water	1 ounce

used freshly mixed.

II.—Potassium bromide	15 grains
Water	1 ounce
III.—Ammonia (·880)	1 drachm
Water	1 ounce

The plate is softened for one minute in water, 1 ounce of No. I. is applied for one minute, and then 3 minims of II. and III. are dropped into the developing cup, and the pyrogallic solution poured back. This is again poured on, and the image develops. When development flags, 3 minims more of Nos. II. and III. are again added till sufficient density is obtained.

For their rapid plates (and, indeed, for most rapid plates to be be found in the market), and also for plates prepared as in Chap. XVIII., use the following :—

I.—Ammonium (·880)	... ...	1 ounce
Potassium bromide	... ...	60 grains
Water ...	... ...	3 ounces
II.—Pyrogallic acid...	... ...	3 grains
Water ...	... ...	2 ounces

The plate is soaked in water for a minute, when the water is poured off, and No. 2 substituted. From 15 to 20 drops of No. I. are poured into the cup, No. I. returned into it, and applied again. The plate develops rapidly. For our own part we like to add No. I. at two intervals of time, as the development is more under control.

In the formula we gave (page 144), it will be seen that sulphite of soda is used. It is added to prevent discolouration of the pyrogallic acid, which is a readily oxidizable body. Some photographers, however, add nitric acid or citric acid to the pyrogallic acid for the same purpose. When using these last, however, it must be remembered that a certain amount of ammonia is thereby neutralized. If nitric acid be used, 4 minims will be sufficient to keep 60 grains of pyrogallic acid free from colour; if citric acid, about 10 grains should be used.

For removing the yellow colour so often seen in alkaline developed gelatine negatives, also for the use of the alum bath to avoid frilling, see the Chapter on "Defects in Gelatine Negatives."

Hydrokinone Developer.—To develop with hydrokinone the following formulæ are used :—

No. 1.—Hydrokinone	... ...	5 grains
Water	... ...	4 ounces
No. 2.—Ammonia	... ...	1 drachm
Water	... ...	9 drachms

To every 4 ounces of No. 1, 30 minims of No. 2 are added to obtain full intensity. The ammonia may be added gradually—that is, by beginning to develop with 10 minims first. The colour of the negatives by this developer is excellent, and the solution remains light.

Ferrous Oxalate Developer may also be used with advantage. If the plate has a glossy surface, and has been prepared with hard gelatine, we recommend that it be soaked for five minutes in ordinary water, in order to cause the gelatine to expand vertically, and so to soften the film, after which time the water is poured off. If the surface be matt, we recommend that the plate be not wetted. Two developing solutions are prepared. A saturated solution of ferrous oxalate in potassium oxalate is prepared as given at page 101, and sufficient of it necessary to develop all the plates which it may be desired to do is diluted with an equal bulk of water,* and when the slight precipitation of ferrous oxalate has taken place, sufficient of the dilute solution to well cover the plate is poured over its surface and watched for half a minute. If the image appears to be developing fairly well, and detail coming out, this developer is continued till all detail appears, when it is poured back into a developing cup, and density obtained with fresh undiluted solution of ferrous oxalate, to each ounce of which 10 drops of a 10-grain solution of potassium bromide are added. This gives density. The development should be continued till the image appears *well* on the surface of the gelatine next the glass plate, supposing the film to be of medium thickness. Some people recommend that the dish be not rocked to and fro; but we think it better to give a gentle motion to the liquid, as we have found that sometimes fog is induced by not so doing.

Instead of the image coming out properly with the developer as indicated above, we will suppose that after half a minute the high-lights only slightly appear. In this case, to each ounce of developer 20 drops of a solution of sodium hyposulphite made as follows are dropped into the cup, and the dilute developer poured on to the hyposulphite :—

Sodium hyposulphite	2 grains
Water	1 ounce

The mixture is once more poured on to the plate, and if not much

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* Perhaps the best plan is, when the concentrated solution, as prepared at page 110, is made, to dilute it with an equal bulk of water before filtering. Some ferrous oxalate will be thrown down, and, of course, can be utilized afterwards.

under-exposed for the normal developer, the details should appear rapidly and with good gradation. When all detail is out the plate is washed, and the strong ferrous oxalate solution, with the bromide, applied as before, to secure density.

Supposing the plate to be over-exposed when the first developing solution is applied, the details will begin to appear too rapidly. It should be immediately poured off, and the plate flooded with a solution of potassium bromide (5 grains to the ounce of water), which should be allowed to soak into the film for a couple of minutes. It is then drained off. To each ounce of the weak solution 20 drops of the same solution may be added, and the developer applied again. This should allow the image to come up properly without flatness, but it may be desirable to finish with the strong solution as before.

Some photographers like to use old ferrous oxalate solutions, to which sodium hyposulphite is added at the commencement. This, no doubt, gives brilliant pictures, but is apt to cause the necessary exposure to be prolonged.

On the whole, we recommend tolerably fresh ferrous oxalate if the greatest benefit is to be obtained from the developer. It must be recollected that Dr. Eder's developers (see page 102) are not so strong as those we have supposed we are using; they may be used of full strength. Either developer, however, can be used with the sodium hyposulphite, and the difference between their detail-giving powers is then very small.

There are some plates which are unsuited for ferrous oxalate development. They are generally those which are prepared with soft gelatine in hot weather. The film shows reticulation, and the image appears granular. In that case resort should be had to alkaline development, by which this evil will be mitigated.

The Alum Bath.—After development, by any method, the plate should be placed in a saturated solution of potash alum, which is conveniently held in a dipping bath or flat dish. The plate is first rinsed under the tap. This bath prevents frilling; but in the case of ferrous oxalate development it does more—it decomposes any calcium oxalate which may be formed by the water (containing lime) with which the developer is washed off. After a couple of minutes' immersion in this bath, it is washed under the tap, using a gentle stream of water, when it is ready for the fixing bath.

Fixing the Negatives.—The formula for the hyposulphite fixing solution has been given at page 52, and need not be repeated. The strength there noted is perhaps rather great for many commercial plates, and it might be made up to about 1 ounce of hyposulphite to a half-pint of water. This reduces the chance of frilling. The use of cyanide is said to be inadmissible, as it attacks the image.* The plate is known to be fixed by looking at the back of it, which should appear black, without any shade of green about it. The fixing should take place in the dark room, as a rule, though if the plate be alumed it will not suffer; if it has not been alumed, it will veil, and with alkaline developer often shows green fog.

After fixing the negative, it has to be thoroughly washed unless it has to be intensified by Edwards' intensifier (see page 152). There are various contrivances for effecting this. A trough with vertical grooves to fit the plate is sometimes employed, which is a good plan where many negatives have to be washed, since the heavier saline solution sinks to the bottom of the water with which the trough is filled. Where only a few negatives are to be washed, flat dishes answer, about four changes of water being given, each change being made at the end of every half-hour. To ensure thorough elimination of the hyposulphite, the plate may be subsequently immersed in the alum bath, and again washed. It must be recollected that thorough washing of any film depends on its thickness, and we may say that as a rule, we consider six hours not too long washing for a thick film. When the plate is considered washed, if it is not to be intensified, it may be placed in a rack and allowed to dry spontaneously. If rapid drying be required, it may be flooded three times with methylated spirit, when it will dry very readily, and can even be accelerated by a gentle heat.

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* A dilute solution can, however, be used.

CHAPTER XXI.

INTENSIFYING AND VARNISHING GELATINE NEGATIVES.

Silver Intensification.—This part of the gelatino-bromide process is one which has to be carried out with the very greatest care, since all methods of giving intensity have yet to stand the test of time. Now, as a rule, a gelatine negative has to be intensified *after* fixing, since the opacity of the film is usually so great that the operator is unaware what density his negative has taken under development. The great desideratum is a good silver intensifier, but this is fraught with so many dangers that great precautions must be taken to ensure success. It may be laid down as an axiom, that to be successful the whole of the hyposulphite of soda and silver must be eliminated from the film, and where the film is of any thickness, this is by no means a matter of taking a short time. The writer finds after the green tint of the unacted-upon salt has disappeared in fixing, the plate should be placed in fresh hyposulphite, and kept there for a short time. This being done, the plate had better be kept in water for an hour or more, the water being changed at intervals. After this, the gelatine film may be made more secure by applying to it a solution of *peroxide of hydrogen* in water. A drachm of what is called a 20-volume solution to 5 ounces of water is sufficient. When it has soaked in this for half-an-hour, it is again washed, and intensification can commence. Another plan is, after thorough washing, to immerse the plate in fresh alum solution for half an hour, again washing thoroughly, and allow to dry, and then the intensifying may be proceeded with. Those who may have endeavoured to intensify with pyrogallic acid and silver (No. 1, page 48) a negative treated in the ordinary way will find that red stains occur almost invariably where the film is thickest—that is, where the hyposulphites have not been thoroughly eliminated; and to eliminate them this entra precaution above indicated is necessary. The formula for the iron intensifier given at No. 2, page 28, is recommended.

It by no means follows that a film thus intensified would be free from a liability to change in the presence of light, since the silver might partially combine with the gelatine. After density has been attained, the plate is washed and put in a dish containing common salt, and once more passed into the fixing bath for a few seconds, again washed, and then dried.

Mr. Dudley Radcliffe has slightly modified the above, and he, too, recognizes the importance of eliminating the hyposulphites. To eliminate them, he places the film, face downwards, in water in a pie-dish, in which the heavier solution sinks to the bottom. He intensifies with the following:—

Sulphate of iron and ammonia... ...	1 ounce
Lump sugar	1 ,,
Glacial acetic acid	2 ounces
Albumen of	1 egg
Distilled water	20 ounces

The albumen is added after the other ingredients are dissolved.

We have heard of failures with these methods, and, when traced to their source, have almost invariably found that they arise from intensifying negatives which have been exposed to the air. It is no uncommon thing to see on each an iridescent film, to which, if silver be applied, staining is certain. In this case a very dilute solution (5 grains to the ounce of water) of potassium cyanide should here be applied, and, after well washing, the intensification may begin. Cyanide will generally remove any red stain which may occur if the above hyposulphite, destroying solutions have been applied first.

Mercury Intensifiers.—The next intensifiers are the mercury intensifiers, which may be classed as the most uncertain in their action and in the permanency of their results. The negative can be intensified either immediately after the washing which follows the fixing, or it can be employed upon a negative which has been dried. In the latter case the negative must be steeped for a minute or two in water. Mr. England recommends the following as giving him what he desires :—

Mercuric chloride (bichloride of mercury)	20 grains
Ammonium chloride	20 ,,
Water	1 ounce

After the negative has been thoroughly washed, the above solution is poured over it till the surface assumes a grey tint. After a thorough wash, a weak solution of ammonia (10 drops to 1 ounce of water) is applied till a dark tone is assumed by a reflected light, and brown by transmitted light. With collodion, the intensity thus given is unstable, and the film has a tendency to bleach.

Mr. B. J. Edwards' intensifier is as follows :—

No. 1.

Mercuric chloride (bichloride of mercury)	60 grains
Water	6 ounces

No. 2.

Potassium iodide	90 grains
Water...	2 ounces

No. 3.

Sodium hyposulphite...	120 grains
Water...	2 ounces

The iodide solution is poured into the mercury solution, and then the solution of hyposulphite, which dissolves the iodide of mercury which has been formed.

The negative is fixed and washed, and the plate immersed in the above solution. Mr. Edwards says of it : "The intensifier acts very quickly, a few seconds being sufficient to give printing density to the thinnest negative. If required to work slower, add more hyposulphite, which will also alter and improve the colour of the negative. The shadows remain quite clear, there is no loss of detail, and the colour of the negative is all that can be desired. The negative must finally be well washed."

Another intensifier with mercury is recommended by Dr. Eder. It is as follows:—The negative is whitened by mercuric chloride as in Mr. England's intensifier, and after thorough washing it is immersed in—

Potassium cyanide	10 grains
Potassium iodide	5 ,,
Mercuric chloride	5 ,,
Water...	4 ounces

The negative becomes dark at first, but a stage is reached when the darkening gives place to a lighter colour, before which it should be withdrawn and washed. This is a good intensifier.

The Platinotype Company uses an intensifier which is composed of mercuric chloride and a salt of platinum. The intensifying action of this liquid is gradual and effective, and the negative seems to remain unaltered by time, which is more than can be said when Edwards' intensifier is used.

Uranium Intensifier.—Dr. Eder, in his "Modern Dry Plates," has recommended an uranium intensifier which is made as follows :—

Uranium nitrate	15 grains
Potassium ferricyanide...	15 ,,
Water	4 ounces

Before using this the plate must be thoroughly washed, as traces of hyposulphite cause a reduction of the uranic salt, and a consequent slight chocolate-coloured veil over the shadows. The plate is immersed in this, and the details in the shadows are first attacked, and then the half-tones, and finally the high-lights. This intensification is permanent, and can be used with much advantage. After silver intensification we prefer this one, on account of its simplicity and permanency. Dr. Eder says that if a negative will not acquire sufficient intensity with uranium, it may be laid aside as useless, and with this we agree.

Varnished negatives may be intensified by removing the varnish first in warm methylated spirit, and, after rinsing under the tap, a tuft of cotton-wool should be applied to the surface.

Varnishing Gelatine Negatives.—When the plate is dried after intensification or fixing, it is varnished; this is done to protect the film from the silver in printing; but, in order to avoid any chance of marking of the film, and before any varnish is applied, it is preferable that it should receive a coating of plain collodion.

If it has received one to avoid frilling (see page 158), it will be unnecessary to give it another. When the collodion is used, the writer's experience tells him that almost any varnish will answer. Enamel collodion is, perhaps, the best to employ; or it may be made by dissolving 6 grains of tough pyroxyline in half-ounce of ether and half-ounce of alcohol (·820). The collodion is poured in a pool at the upper end of the dried plate, and flowed first to the right-hand top corner, next to the left-hand top corner, third to the left-hand bottom corner, and finally, as much as possible is drained off in the bottle at the bottom right-hand corner, giving the plate a gentle rocking motion in order to cause all lines to coalesce. The plate is then set up and allowed to dry. For a varnish, Mr. England uses seed lac in methylated spirit (a saturated solution), and then thinned down till it is of a proper consistency. The Autotype Company prepare a special varnish for gelatine plates, as does Mr. Hubbard one to use as a retouching medium. To apply the varnish, the plate should be gently warmed over a spirit-lamp or before the fire to such a heat that the back of the hand can only just bear the touch of the plate. The varnish is applied like the collodion. After draining off all excess, and rocking the plate, it is warmed till all spirit has evaporated, and till the film is glossy. A lack of warmth will cause the film to dry "dead." Where many prints are not to be taken, it is believed that the film of collodion alone is a sufficient protection against the silver nitrate of the paper combining with the gelatine, and so causing a discolouration. If a negative does get discoloured through this, a very dilute solution of potassium cyanide will usually clear away any marking that may have been made. But great care must be taken in using this solvent of the silver compound, as it attacks metallic silver when in such a state of fine divisicn as that in which it is to be found in the gelatine plate.

CHAPTER XXII.

GELATINO-CHLORIDE.

Gelatino-Chloride.—For some purposes a chloride emulsion in gelatine is useful. The method of procedure is precisely that given in Chapter XVIII., using the boiling process (see page 132). Instead of the formula given (the same page), the following is employed:—

I.—	Sodium chloride	80	grains
	Nelson's No. 1 gelatine	30	,,
	Hydrochloric acid	1	minim
	Water	1½	ounces
II.—	Silver nitrate	200	grains
	Water	½	ounce
III.—	Nelson's No. 1 gelatine	30	grains
	Water	1	ounce

The above are made into solutions, and in the dark room. II. and III. are mixed at a temperature of about 100°, and then I. added, as described in Chapter XVIII. The emulsion may be boiled for a quarter of an hour, or left unboiled. In either case, 240 grains of Autotype gelatine, or a similar total quantity of equal parts of hard and soft gelatine dissolved in two ounces of water, are added. After setting, the emulsion is washed, and plates coated as described in Chapter XIX.

These plates, made from unboiled emulsion, are very transparent, and of a deep orange colour by transmitted light, whilst those made from the boiled emulsion are blue or sap-green.

Though extremely sensitive to daylight, they are much less so to gaslight; so that more artificial light may be used during development than with bromide plates. This will be found to be of great advantage, as the plates may be examined from time to time within a reasonable distance of a gas flame, and the density thus regulated to a great nicety.

The exposure of the plates to diffused daylight (made with unboiled emulsion) will vary from one to five seconds, and the plates prepared with the boiled emulsion for from a quarter to two seconds, according to the density of the negative; whilst to an ordinary fish-tail gas burner or paraffin lamp at 12 inches distance the former will require from five to twenty minutes' exposure, and the latter from half-a-minute to three minutes. Mr. A. Cowan states that a very reliable method of exposing when a number of pictures are required exactly alike—or when it is necessary to work at night—is to burn one inch of magnesium ribbon at from 9 to 24 inches from the negative, according to its density.

Development is effected by the ferrous citrate or ferrous citro-oxalate developers (see pages 101 to 103), or by hydrokinone (see page 103) diluted to quarter strength, to which a few drops of a saturated solution of sodium chloride are added.

The development is carried out in a dish, which is kept rocking. An unboiled emulsion gives a warmer tone than a boiled one.

Mr. A. Cowan has made a large number of experiments with chloride emulsion, and by a modification in development has been able to produce images which, by transmitted light, give any colour from warm tones to black.

No. 1, for Cold Tones.

Potassium citrate	136 grains
Potassium oxalate	44 ,,
Hot distilled water	1 ounce

No. 2, for Warm Tones.

Citric acid	120 grains
Ammon. carb....	88 ,,
Cold distilled water	1 ounce

No. 3, for Extra Warm Tones.

Citric acid	180 grains
Ammon. carb.	60 ,,
Cold distilled water	1 ounce

To 3 parts of either of these add 1 part of the following at the time of using :—

1. Sulphate of iron, 140 grains; 2. Sulphuric acid, 1 drop; 3. Distilled water, 1 ounce,

keeping the dish rocking; the time required for development will vary from one to ten minutes, according to the developer used and the density required. No. 1 is the quickest, No. 3 the slowest developer.

A great variety of tones may be obtained by mixing the first and last developers together in different proportions, and altering the exposure to suit the developer.

The addition of from 5 to 10 minims of a 10 per cent. solution of sodium chloride to each ounce of developer considerably modifies the colour, and allows of a much longer exposure. It is valuable when very rich, warm tones are required.

Still further differences in colours may be obtained by mixing one of the following with any of the preceding. The first three are, however, what Mr. Cowan recommends :—

No. 4.

Magnesium carbonate	76 grains
Citric acid	120 ,,
Water...	1 ounce

No. 5.

Sodium carbonate (common)... ...	205 grains
Citric acid	120 ,,
Water...	1 ounce

To 3 parts of these 1 part of the sulphate of iron solution is added, as with Nos. 1, 2, and 3.

After development, the plates are washed, and fixed in clean hyposulphite of the usual strength (page 52).

The plates are then finally washed as usual.

Plates prepared with the emulsion, if kept exposed to the air, are apt to tarnish, and then develop badly. They should be carefully wrapped in paper, and sealed up in tinfoil.

The exposure of a boiled emulsion plate is considerably shorter than that required for a wet plate, but for an unboiled emulsion longer. Transparencies may be taken in the camera or by contact with these gelatino-chloride plates.

CHAPTER XXIII.

DEFECTS IN GELATINE PLATES.

Frilling.—What is meant by frilling is the gelatine film leaving the glass plate in folds or wrinkles, and a greater nuisance than this cannot be met with. It generally occurs when fixing the plate, though we have sometimes met with it during the development, especially in hot weather. We will endeavour to state the causes of frilling as far as they are known. Frilling is often caused by the use of unsuitable gelatine, possessing but little tenacity. The more the qualities of gelatine are like glue, the less chance there is of meeting with this vexatious evil. If gelatine, however, were like glue in respect to hardness, the difficulty of developing a plate would be very great, since it is too hard. The addition of chrome alum to an emulsion also prevents frilling to a great extent. The objections to chrome alum are that it increases the tenacity of the gelatine, and prevents easy development; hence it should be used sparingly.

Gelatine that has been heated for a long time has a special tendency to frill, and, unless fresh gelatine be added to the emulsion, in some cases frilling is inevitable. Long cooking (in warm weather particularly) means decomposition of the gelatine, and decomposed gelatine is very detrimental in preparing a dry plate. Boiling for a short time has much the same effect on the gelatine as cooking at a lower temperature; hence, to avoid frilling, it is better on the whole not to boil the emulsion with the full amount of gelatine.

Another source of frilling is the plate being improperly cleaned. If water will not flow in a uniform sheet from a plate, it may be well understood that there will be but little adhesion between it and an aqueous solution of gelatine. This we believe to be one fruitful source of the evil.

Another source of frilling is unequal drying. Thus, if plates be dried in an unventilated box, it will usually be found that a central patch refuses to dry till long after the outsides are completely desiccated. At the junction of this central patch with the neighbouring gelatine frilling is to be looked for. It will spread to the parts which have been the longest in drying. This is due to a false tension set up in the film, and can only be conquered by drying the plate by means of alcohol, or by using a proper drying cupboard.

Again, when plates are coated in hot weather, unless precautions are taken of cooling the slabs on which they are placed, they take long to set. The emulsion remains liquid on the plate for sufficient time to allow the heavier particles of silver bromide* to settle down on the surface of the glass. This of course diminishes the surface to which adhesion can take place. We believe that most of the frilling which takes place in plates prepared in hot weather may be traced to this cause. When washing after fixing, frilling is often caused by allowing a stream of water from the tap to impinge on the plate. This should never be allowed if the film is at all delicate. Plates which frill or blister will often not show any signs of so doing if kept for a few months.

A general remedy for frilling is to coat the plate with normal collodion containing about six grains of tough pyroxyline to the ounce of solvents. The formula would be thus :—

Tough pyroxyline	6 grains
Alcohol (·820)	½ ounce
Ether (·725)	½ ,,

This may be applied to the film immediately before developing the plate ; the solvents are washed away in a dish of clean water first, and, when all repellent action is gone, the developing solutions applied. If the film has been allowed to dry, a solution of one part of ether to three of alcohol will render it pervious to the developing solutions.† In some batches of plates frilling

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* This is particularly liable to happen when the emulsion has been long boiled or carelessly mixed.

† We have found this essential in intensifying negatives which have been treated with collodion after fixing and drying.

is so obstinate that, although collodion be applied, the film has a tendency to curl off from the edges of the plate. It is advisable, when such is suspected, to run a brush with an india-rubber solution round the edges, to prevent the water having access to that part of the film. When fixing such plates it not unfrequently happens that blisters appear, and, if allowed to remain as they were, will spoil the negative. To avoid this, we wash the plate under the tap till all the blisters join, and the film presents the appearance of a sack containing water. A prick at one corner of the plate lets this liquid free, and the washing can take place as usual. The obstinate cases of frilling usually occur through plates being prepared in very hot weather, and the film being dried without first setting.

Some writers state that, by immersing the plate in a saturated solution of Epsom salts, frilling is avoided: we have not succeeded ourselves in proving its efficacy.

Blisters on the Film.—Blisters on the film are the usual preliminaries to frilling. When they commence, further damage may usually be avoided by flooding the plate with methylated spirit. This extracts the water, and with it any soluble salt that may be left, and the plate speedily dries, which is an advantage if it be fixed. Blisters are usually found to follow the rubbing marks of the polishing cloth, if such be used. The cure here is self-evident. They also are to be found in places between which the film has dried quickly and slowly.

Red Fog.—The writer fortunately knows very little about this disaster, but it is found to occur if the silver nitrate is in excess of the salts with which it should combine. Cyanide will sometimes eliminate it from a film, but this remedy must be used with caution.

Green Fog.—This fog is green by reflected light, and pink by transmitted light, being dichroic. Experiment points to it being reduced metallic silver in an exceedingly fine state of division, this reduction being aided by decomposed gelatine. In some cases we have immersed the film in a strong solution of bichromate of potash, and on afterwards washing, the fog has disappeared; but whether it is a certain cure, we hesitate to say; it is, at any rate, worth trying.

The writer has recently found that green fog can be eliminated from a plate if, after fixing and washing, it is treated with a ferric salt. The following seems to answer satisfactorily :—

Ferric chloride	50 grains
Potassium bromide	30 ,,
Water	4 ounces

This converts the image into silver bromide, and at the same time bleaches the green fog, which, seemingly, is a deposit of silver mixed with a constituent of gelatine. The plate is then washed to get rid of any great excess of the iron salt, when it is treated with ferric oxalate developer. This reduces the bromide, with slightly increased density, to the state of metallic silver, and the green fog is replaced by a *very faint* deposit of metallic silver, which in no way interferes with the printing. Green fog is never seen when using ferrous oxalate, which has not an alkaline reaction.

General Fog.—By general fog we mean the fog produced in development, caused by the partial reduction of the silver salt all over the film. This is probably due to the decomposition of the gelatine by long cooking, the products of which in the presence of a developer are apt to react on the silver salt, and produce a partial reduction in it. The production of this kind of fog, and electrical disturbance in the atmosphere, are apt to go together. In unfavourable weather, a few drops of a solution of carbolic acid should be added to the gelatine during boiling or prolonged emulsification; this will generally check or entirely prevent the decomposition. An excess of silver is likewise very likely to produce the evil, but the presence of iodide in the emulsion will almost certainly cure it. Another fruitful source of fog is the light admitted to the plates during preparation or development. The light should be tested by putting a plate in the dark slide, and drawing up half the front, and exposing the half-plate to the light for ten minutes. If the fog be due to this cause, the plate on development is sure to show it by a slight reduction of metallic silver in the part so exposed.

Whatever may be the cause of fog—if the emulsion be not hopelessly in fault, or if the plates have seen light—we have found that, as in the collodio-bromide process, there is one certain sure cure. If the emulsion be slightly at fault, squeeze it into water containing 10 grains of potassium bichromate to each ounce, and allow it to rest for a hour, and then wash again for a couple of hours more. If all the bichromate be not taken out by this washing, it is not of much consequence, since, when dry, it is inactive. The sensitiveness after this treatment is not much diminished, and the negatives taken with it are beautifully bright. Plates may be treated in precisely the same manner, and give unveiled pictures. There is a *slight* diminution of sensitiveness if the bichromate be not all washed out, but nothing to hurt except where very great rapidity is required.

A cure for any emulsion is the addition of a few grains of cupric chloride. This diminishes the sensitiveness, but is most effectual, negatives yielding bright and brilliant images. A remarkable fact about the addition of the cupric chloride is, that the grey form of bromide is converted into the red form if much of the copper salt be employed. The addition of a few grains of ferricyanide of potassium with a little bromide of potassium (according to Dr. Eder) is also a perfect cure, but this slows the emulsion.

Another method is to add two drops of a mixture of hydrochloric and nitric acids slightly warmed, so as to change the colour of the emulsion, or to slightly acidify the first wash water with it ; about 1 drachm to a pint of water is generally ample. The length of time which the emulsion should be in contact with the acidified water depends on the size of the mesh of the canvas through which the emulsion is squeezed. For a medium size, half-an-hour suffices. The emulsion has a tendency to become insoluble by this method.

Flatness of Image is usually due to over-exposure and development with the alkaline developer : the use of ferrous oxalate mitigates the evil, whilst if iodide be in the film, we have never found any great lack of density to arise. Feebleness of the image is also often caused by too thin a coating of emulsion, or an emulsion poor in silver salt. A thick film is a desideratum, giving all the necessary density to the image with facility. When a vigorous image is required, it is most readily obtained by using a *freshly-prepared* and strong ferrous oxalate solution (see page 101).

Too Great Density of Image is sometimes met with, and can be remedied by applying ferric chloride to the film, and then subsequently immersing in the hyposulphite of soda fixing bath.

The formula recommended is—

Ferric chloride...	1 drachm
Water	4 ounces

This is flowed over the plate a short time, and then, after washing, the plate is immersed in the fixing bath. The solution acts very vigorously, and should be diluted if only a small reduction is required. Local reduction may be effected by using a paint brush charged with this solution on the moistened film. This practice is not, however, much to be commended, as it is rather working in the dark.

Density may also be diminished by the use of a strong solution of cyanide. Local reduction may be given by moistening the parts required to be reduced with water by a paint brush, and then applying the cyanide in the same manner. The reduction can be seen progressing.

There are a variety of formulæ extant for reducing negatives. Perhaps the best is eau-de-javelle, which can be obtained of all chemists, but which is made as follows:—

Dry chloride of lime	2 ounces
Carbonate of potash	4 ,,
Water	40 ,,

The lime is mixed with 30 ounces of the water, and the carbonate dissolved in the other 10 ounces. The solutions are mixed, boiled, and filtered. The filtering solution should be diluted, and the plate immersed in it till reduction takes place. The plate should be fixed, and again washed.

Yellow Stains.—Usually a yellowish veil appears to dim the brightness of the shadows when the development has been effected by the alkaline developer. This may be removed, if thought requisite, by the application of one or two drops of hydrochloric acid to an ounce of water, and floating it over the surface of the plate. This must be done after the negative has been freed from hyposulphite, otherwise the acid decomposes this salt, and there is a deposition of sulphur. Mr. Cowell has recommended another clearing solution, which is made as follows:—

Alum	1 ounce
Citric acid	2 ounces
Water	10 ,,

Mr. B. J. Edwards makes this solution sherry-coloured with ferric chloride, but we do not find any marked advantage in so doing. The film must be washed almost immediately, as the acid is apt to cause frilling.

Another formula is—

Saturated solution of alum	... 20 ounces
Hydrochloric acid	... ½ ounce

The negative should be well washed in all cases after the application of either of them.

Too Granular an Emulsion is usually due to bad mixing of the soluble bromide and the silver nitrate; but it may also be caused by over-boiling, and also by too small a quantity of gelatine in the boiling operation. Digesting too long with ammonia, as in Van Monckhoven's process, has the same effect. There is no cure for this evil.

Opaque Spots on a plate are almost invariably due to dust settling on the film when drying; they also may be due to imperfect filtering of the emulsion.

Semi-transparent Spots on the plate before development are generally due to (1st) excrescences on the glass plate, or (2nd) to the use of gelatine containing grease.

As has already been pointed out, certain gelatines are apt to contain grease, and that so intimately that soaking in ether or washing with ammonia will not eliminate it. A specific is as follows:—We will suppose that 80 grains of Coignet's gelatine are required: 90 grains are weighed out, soaked in water, drained, and melted. The liquid is then very slowly poured, almost drop by drop, into methylated spirit, free from resin, where it is precipitated in shreds of a white pasty character; after it is all precipitated the spirit is poured off, and a slight rinse with fresh spirit given, and then it is covered with water, in which it should remain till the whiteness disappears. The water should then be changed, and the gelatine drained and re-dissolved; about 10 grains out of the 90 seem to be dissolved in the mixture of alcohol and water. Emulsions made with this gelatine will be markedly free from grease spots. The same method may be adopted for large quantities of gelatine, omitting the final wash with water, and leaving it to dry spontaneously. This is best done on glazed dishes. The gelatine can be broken up, weighed, and used in the usual manner. Another plan is to soak the gelatine in water with a full quantity of water; drain off what can be drained off, pressing the gelatine during draining. The gelatine is next melted, and to every 100 grains used ¼ ounce of strong ammonia is added. When set, the gelatine is squeezed through netting, and washed till an alkaline reaction is only just shown on red litmus paper. All grease is saponified and washed out to a great extent. The gelatine may be added to the boiled emulsion in the moist condition.

Dull Spots on the Negative are also due to the use of gelatine which contains greasy matter. They seem to be formed by the repellent action of the gelatine for the silver bromide. If a plate be carefully examined by daylight, the dull spots can be seen before development, and are seen to be placed where the surface is denuded of gelatine, and, there being no restraining action by the gelatine, these are first reduced by the developer. If a plate which shows such repellent action be coated with a weak solution of gelatine or albumen, and then be dried, the evil will be much mitigated. The dull spots are usually met with in most aggravated form in hot weather, when the emulsion takes long to set, and, consequently, when the repellent action has longer to develop its power. In hot weather the slab should be cooled with ice to avoid this evil.

Pits are, in reality, an aggravated form of dull spots. The repellent action in this case is able not only to cause the gelatine to be repelled, but also to carry with it the bromide as well.

Want of Density in a negative may be caused by over-exposure, but it more often arises from the emulsion itself.

A rapid emulsion has a tendency to give a feebler image than a slow emulsion, although to form the image the same amount of silver may be reduced. This shows that the silver is in such a state of aggregation that it does not possess what may be called covering powers. We have found that the addition of a chloride emulsion materially aids the production of density. If one-fifth part of an emulsion prepared according to Chapter XVIII. be added to an emulsion lacking density-giving qualities, it will be secured without detriment to the sensitiveness. The range of sensitiveness will be slightly altered (see page 5). A hard gelatine is also conducive to feeble images. If prepared plates give feeble images, resort must be had to intensifying.

Irregular-shaped Spots, which refuse to develop, are often caused by the use of chrome alum in emulsions which contain free alkali. Ammonia causes a precipitate with chrome alum, and this encloses particles of bromide, and prevents the action of the developer upon it.

Transparent Pinholes on the negative after fixing may arise from minute air-bells in the emulsion, or from dust which finds its way into the slides or changing-box. The former disappear if the emulsion is kept before coating. The latter can be avoided by rubbing the dark slides with a minute trace of glycerine. This acts as a trap for the dust, and prevents its finding its way on the plates.

Dark Scratches on the Negative.—Sometimes plates on development show dark scratches, which appear unaccountable. If the plates have been rubbed together, or if any grit has been rubbed on them, this will account for the markings.

CHAPTER XXIV.

PAPER NEGATIVE PROCESSES.

The following are modifications of the original calotype process which have yielded excellent results in many hands. It is therefore given in detail. Large pictures may be produced by it which can *very nearly* bear comparison with those produced with wet plate negatives. Calotype is convenient, owing to the small weight that it is necessary to carry.

Buckle's Process.—The following process is the best of a variety:—

No. 1.—	Silver nitrate	35	grains
	Distilled or purified water	½	ounce
No. 2.—	Potassium iodide	35	grains
	Distilled water	½	ounce

Mix these two solutions,* and a precipitate will be formed; and if the above proportions of water be maintained, the precipitate will retain a more solid and condensed nature, separating itself more readily from the supernatant fluid than would be the case if smaller amounts were used. The deposit of silver iodide should be washed in small portions of water (one ounce to each washing being sufficient), as large quantities render the deposit too fine. The method of washing is as follows. The supernatant fluid should be carefully decanted from the iodide, the fresh water should next be added, and the deposit briskly stirred in it with a glass rod. When well settled, the water should be

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* The potassium iodide solution should invariably be poured on the silver nitrate solution.

decanted. The operation of washing should be repeated three or four times.

The iodide must now be re-dissolved by a solution of potassium iodide in two ounces of water. The best way of effecting this is to place the precipitated silver iodide in a two-ounce measure with the two ounces of water and six drachms of potassium iodide. This will not effect the solution of the silver iodide, but extra crystals of the potassium salt should be added till it is complete—that is, till the liquid is just *not* clear, or in a semi-transparent state. Should this solution of iodide of silver be too powerful and too thick when coating the paper (which is shown by a deep sulphur-colour instead of pale primrose on the paper), 2½ ounces of water may be used instead of the 2 ounces.

The paper to be used should be as tough and grainless as possible, and without any sign of holes or thin places. Good English-made paper of the consistency of medium Saxe answers as a substitute.

Cut the sheet of paper into convenient sizes, and pin it by its corners on to a flat smooth board. Apply the solution with a cotton-wool brush evenly and plentifully. The accompanying figure shows a cotton-wool brush which answers well for the purpose required. A glass tube, A, is cut off from a length of ¼-inch soft glass tubing, by filing round it with a file at about 4 inches from one end. A slight jerk will break off this piece, and the ends are slightly heated in a flame to take off the sharp edges. A loop of string, *b*, is passed down the tube, and cotton-wool inserted in the loop. The ends are then pulled, and the loop carries a portion of wool into the tube, the greater part remaining outside to form the brush.

The paper must be allowed to dry partially. Next wash the sheet in rain or distilled water, taking care to dispel all air-bubbles, and, having agitated it, leave it in the water whilst a second sheet is coated. When this second sheet is ready for immersion, withdraw the first sheet from the pan and place it in a second dish (likewise containing rain or distilled water), and place the second sheet in the first pan, and so on. When well washed in the second pan, the paper ought to assume a bright uniform yellow colour, tending to green. The washing will take from one to two hours. Pour off the water, and rinse two or three times, drain, and hang the sheets up by one corner to dry.

The paper in this state is nearly insensitive to light, and can be kept between leaves of a book or blotting-paper.

To render sensitive, pin the paper to a board in the dark room, as before described, having previously prepared—

No. 1.—	Silver nitrate	50 grains
	Distilled water	1 ounce
	Glacial acetic acid	80 minims
No. 2.—	*Saturated solution of gallic acid in distilled water.	

Take six drops of No. 1, add to it six drachms of distilled water, next six drops of No. 2, and finally add from one to three drachms† of distilled water again. The mixture should then be well stirred with a glass rod. Apply this solution lightly, but plentifully, with the cotton brush to the iodised paper, blot off the sheets in succession, and place two back to back with blotting-paper between them.

In very hot climates, twelve drops of No. 1 and seven of No. 2 may be substituted with advantage for the proportions given above.

A plate of glass of the size of the inside of the camera slide, and having the thickness necessary to bring its surface to a level with the top of the supporting silver wires, having been selected, the corners are broken off. The glass should then be placed in the frame; the back surface of it will now be on a level with the inside of the silver wires. On this plate place the sensitized paper, and back it with another glass plate. When in the camera, the paper will coincide with the front of the ground glass. By attaching the corners of the paper by gum to one glass plate the use of the second may be avoided.

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* A stock bottle of gallic acid may be kept, filling up with water, and shaking well after any of the solution is taken out. If all air be excluded from the bottle, it will not turn brown or discolour.

† Heat quickly decomposes a strong solution of Nos. 1 and 2, consequently the greater the heat the larger should be the quantity of water added. This method of mixing also prevents the instantaneous decomposition of the solution.

For a fifteen-inch focal distance single landscape lens, full aperture, three minutes in bright light will suffice. This may give some sort of a guide for exposure with other lenses.

To develop the image, take the paper out of the dark slide, and pin it on the board as before. Apply equal parts of Nos. 1 and 2, with equal quantities of water, with the brush, and allow the developing action to proceed until it begins to flag. Next apply the solution of gallic acid *very* slightly until the deep shadows begin to dim by transmitted light. The development must then stop, otherwise fog will ensue. The development is easily arrested by placing the paper face downwards in water, and using three or four changes, allowing a quarter to half-an-hour between each change. If, on opening the dark slide, the image on the paper appear perfectly defined, and of a dirty red tint, it is a sign that the exposure has been too long. In this case use one part of No. 1 to two parts of No. 2. Should under-exposure be suspected, two parts of No. 1 to one part of No. 2 should be the proportions employed. On foliage or dark shadows which do not develop readily, these last proportions of Nos. 1 and 2 should be applied, but the brush should almost immediately afterwards be dipped in the solution containing the ordinary proportions, and be passed over the whole of the picture, to equalize the development, and to prevent marks arising from the use of the different strengths of developing solution.

The negative is fixed by immersing the developed picture in

Sodium hyposulphite...	2 ounces
Water...	32 ,,

The fixing is complete when all the yellow of the iodide has disappeared. This will usually take about half-an-hour. The paper negative must be washed for two or three hours in running or frequent changes of water, and dried spontaneously.

The negative, when dried, is ready for waxing. A flat iron should be warmed, and a small cake of pure white wax be brought in contact with its point on the back of the negative. The heat melts a certain amount of the wax, which, by moving the iron, can be spread over any desired portion of the picture. Blotting-paper should then be placed over the negative, and the hot iron passed over the surface of the blotting-paper till all superfluous wax is removed. The negative is now fit for printing purposes.

It is usual to wax the whole of the negative with the exception of the sky. Unless the sky be very dense, any portion of it that has been waxed will have to be rendered opaque with indian-ink or its equivalent.

Sensitized calotype paper will only keep two or three days. The quicker it be employed after sensitizing, the better will be the result. The paper which has been coated with iodide, but not sensitized, will keep for an indefinite period if protected from light.

Greenlaw's Process.—First examine and select thin negative paper, and reject all that show any irregularities, holes, patches of unequal density, &c.; that recommended for Buckle's process will answer. Make a solution of—

Potassium iodide	1,000 grains
Potassium bromide	300 ,,
(For much foliage the latter may be increased to 450 grains)	
Distilled water	40 ounces

and add enough of pure iodine to give the solution a dark claret colour. Then filter.

Into this place as many sheets of paper as you can with ease, being careful that no air-bubbles exist. Allow the paper so immersed to rest for an hour; then turn the whole upside down, and hang the sheets up to dry, taking off the last drops with white blotting-paper. This may be done in diffused light. When dry, place sheet over sheet evenly in a portfolio in which no other papers, except blotting-paper, are placed. They will then be iodized a dark purple, which will keep any time. They, however, turn a light brown colour. Be sure, in working, that nothing touches the paper, for the very slightest touch will cause a stain in the development. Prepare—

Silver nitrate...	2½ ounces
Glacial acetic acid	2½ ,,
Distilled water	40 ,,

Now float a sheet of your iodized paper on this (smooth side downwards) until the purple shall have turned an uniform yellow, which is silver iodide. Allow it to rest for one minute; after this, remove and immerse in distilled water, where it should remain for two or three minutes; if to be kept for some time, remove to another dish of distilled water. Place now on clean white blotting-paper, face upward, and remove by blotting-paper *all* moisture from the surface (these sheets can be again used for ironing out the wax by-and-bye); then place between blotting-paper, or hang up to dry; when quite dry, place in your dark slides. Next prepare

Gallic acid	200 grains
Spirit of camphor	1 drachm
Distilled water	40 ounces

This is a saturated solution of gallic acid; unless preserved from the air it decomposes; the spirit of camphor is added to preserve it. When about to develop, filter, and add to every five ounces one drachm of the following solution :—

Silver nitrate	30 grains
Glacial acetic acid	$\frac{3}{4}$ drachm
Distilled water	1 ounce

Pour into your dish quickly, and *immediately* float the picture side of your paper (which is slightly visible on it), being very careful that there be sufficient liquid to prevent the paper from touching the bottom of the dish. Constantly watch until the picture becomes visible on the back, and the paper has a kind of brown, greasy appearance. Continue the development until, in holding up a corner when the sky is before the light, you cannot see your finger when moved about between the light and the paper. If it be not dark enough before the silver gallate decomposes, you have under-exposed. Decomposed gallate of silver ceases to develop.

Do not, when examining your paper, lift more than the corner, as an oxide of gallate of silver forms rapidly on the surface like a crust, and, on replacing your picture, it causes innumerable marble appearances; as also if you do not place your paper speedily on the solution in the first instance. It may be removed by drawing a sheet of blotting-paper over the surface of the solution. Remove to a dish of common water, and wash out the brown tinge caused by more or less decomposed gallate of silver.

We have found that this paper can also be easily developed by a brush. For our purpose we employ a flat badger-hair brush, about three inches in width. The paper after exposure is wetted in a dish and laid upon a sheet of glass, which is placed at an angle of about 60° with the vertical (see fig. 21, page 174). It is then finished with the above solution of gallic acid, and then with the gallic acid and silver. The image appears rapidly, and there is never any danger of a stain from decomposed gallate, as constant fresh solution is applied. Two ounces of solution is found to be capable of developing a 15 by 12 picture, which is far less than would be used by developing as Colonel Greenlaw recommended.

When *well* washed, you may fix the negative by placing it in a solution of sodium hyposulphite, 1½ ounce to 1 pint of water, till every vestige of the yellow silver iodide be removed, after which it is washed in eight or ten different changes of water; you have then a fine, clear, and dense negative.

Process for Alkaline or Organic Iron Development.—Colonel Greenlaw's process may be modified to suit alkaline or organic development. The paper is prepared in the manner given, but it is advisable to reverse the proportions of bromide and iodide. The formula will thus stand:—

Potassium iodide	300 grains
Potassium bromide	1,000 ,,
Water	40 ounces

and the iodine is added for the convenience of ascertaining when the sensitizing is complete.

The paper is floated on the silver solution as usual, but there is no need to introduce the acetic acid; in fact, an ordinary bath prepared for printing will answer well if it be not discoloured. After floating, the paper may be thoroughly washed, and then exposed; or it may be placed in a bath of common salt solution:—

Common salt	400 grains
Water	40 ounces

The paper is allowed to soak in this for ten minutes, when it is washed. A moderate amount of washing suffices, since the presence of a minute quantity of salt is not detrimental to the sensitiveness. The salt prevents the formation of any organic compound of silver. When dry it is ready for exposure, which should be as long as that required for a bath dry plate, or about three times that required for a wet plate. To develop, the paper may be immersed in a solution of—

Strong ferrous oxalate	1 part
Potassium bromide solution (20 grains 1 ounce)	½ ,,
Water	1 ,,

Instead of this, it may be immersed in a solution of ferrous-citro-oxalate (page 103). The development takes place with moderate rapidity, and should be carried on till the image appears perfectly dense by transmitted light. For our own part we prefer to brush the developing solution over the paper, wetting it first, however, with water. The image can then be worked upon by measuring the strength of developer at different parts to bring out detail or intensity. The following sketch will show the plan we adopt.

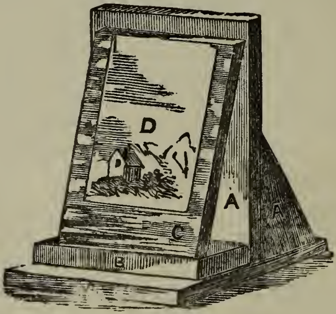

Fig. 21.

A A is a wooden stand, and C a glass plate on which the damped paper is placed, standing in a zinc trough, B. The stand is placed on a table a convenient height at which to apply a brush. All solutions are caught by the trough, B, and perfect cleanliness is thus maintained. A wooden board may be substituted for the glass plate, taking care, however, to place a piece of clean and damped paper on to it, on which to place the paper negative. In this case a couple of drawing-pins may be used to hold the top corners of both sheets. The three-inch badger hair brush is brought into requisition (see page 172), and the image "brushed" out. This method necessitates but a slight amount of developer to be employed, and hence is economical. Should additional intensity be required, it can be given by soaking the print in acetic acid and water, and then applying the ferrous sulphate solution (page 48). The paper is fixed as in the preceding process, and can be waxed as usual.

CHAPTER XXV.

COPYING PLANS, ENGRAVINGS, ETC.

Interiors.—At page 85, allusion has already been made to this method of making long exposures with the wet process. We may add that it is an excellent plan—whether wet or dry plates be used—to give them a backing of asphaltum dissolved in benzine. This totally prevents halation, which is much to be feared. For wet plates the backing should be given to the plate previously to sensitizing. It can readily be scraped off after development, and does the bath no harm. Gelatine plates are above all others suitable for interiors, requiring, of course, much less exposure than a wet plate. A golden rule to remember is, that you can scarcely over-expose, since the shadows are, as a rule, very dark.

Copying Plans.—A most important branch of photography is the copying of plans, sketches, &c. The greatest care should be exercised in the selection of lens and chemicals for the operation, success depending mainly upon them.

A single lens should not be used, owing to the curvature of the image given to the marginal straight lines. This confines the choice to the landscape doublet and triplet, and to portrait combinations. Of these the doublets are the most satisfactory. With lenses obtained from first-class makers there is no distortion; the reflecting surfaces are fewer in number than in the triplet combination, and therefore are to be preferred. The triplet seems to have a flatter field; in bright weather, therefore, when there is plenty of actinic light, it may be used with advantage. Portrait combinations also answer; the general objection to them, however, is that the field is so concave as to be out of focus at the margins, unless one of large diameter be used. Dallmeyer's D lenses have less of this objection. With a large stop they answer for portraits, whilst with a smaller one they answer for copying purposes. No. 6 D lens, by the above maker, will answer for copying plans on an 18 by 15 plate. If a lens of this size be not at hand, the above maker's rapid rectilinear or triplet (for 18 by 15) may be substituted.

If the plan has to be reduced by photography with the aid of a portrait combination, it is preferable to have the front lens next the plan to be copied; if it has to be enlarged, the combination should be inverted, and the back lens placed in front.

Unless a special camera be employed, the rendering the image of the plan, &c., to be copied of a particular size entails considerable labour in shifting the board on which the plan, &c., is fixed.

The following mode of attaining parallelism to the focussing screen answers well. On the centre of the board on which the drawing, &c., is to be fastened, a small mirror may be temporarily fixed. This latter should be strictly parallel to the surface of the board. The point corresponding to the centre of the lens should be accurately marked on the ground glass. On the lens itself an open cap should be fitted, furnished with two cross-threads, intersecting on the prolongation of the axis of the lens. The image of these cross-threads will be reflected by the mirror, and should be focussed. The board should thus be tilted or slewed round till the image of their intersection coincides with the point marked on the ground glass.

The board will now be parallel to the ground glass; the mirror being removed, the drawing may be fixed on to it, and focussed as usual. A neat stand for the board will readily suggest itself, by which it may be moved parallel to the position thus secured, so that the distance necessary to give the exact size required may be attained. The mirror may be let in flush with the board, thus obviating the necessity of its removal for fixing up the drawing. Some photographers let a straight rod into a flat piece of wood, and exactly perpendicular to it. This flat board is placed on the centre of the plan, and the board moved until the sides of the rod are invisible.

A direct light, coming in a horizontal direction, is generally to be preferred for copying, as the texture of the paper is hidden by it. If a vertical light be used, the shadows of the irregularities on the surface of the paper may mar the purity of the whites.* Should the plan be shaded in flat tint, it may be necessary to copy it in direct sunlight, as Indian ink and sepia, and some other colours, are of such a non-actinic nature as to make but slight impression on the sensitive film; strong light lightens up the shades, which are only dark by comparison. For like reasons, plans or engravings on paper which, through age or other causes, has turned yellow, should be copied, if possible, in sunlight.

Copying Oil Paintings.—The light for copying oil pictures should come from the direction in which the light has been supposed to come in the picture itself. A painter "loads" his canvas in such a manner as to give the best effect to his picture when viewed in that particular light. The subject of the wet process for copying paintings is one somewhat difficult to handle. The colours which are brightest in a painting are the yellows, and, as a rule, these have very little action on an ordinary photographic plate. The blues, which are much less luminous than the yellows, come out light instead of dark. There are two methods of attacking tree subjects; one is to use a plate which is equally as sensitive to the yellow rays as to the blues, and the other is to moderate the blue by some kind of artifice. If a collodion emulsion be stained on a light lavender colour with cyanine blue, it will be found that the most non-actinic yellow is capable of being impressed on the plate to the same degree that is the blue, and the harmony of the resulting negative will be proportionally improved. It is hard to give the exact tint to which the picture should be dyed, but the colour of pale lavender gloves is that which is to be aimed at. A wet plate may also be prepared in the same way by colouring the collodion previous to immersion in the bath, development taking place in the ordinary manner. For ordinary paintings a twenty-grain developer may be taken as the standard solution; a stronger or weaker one may be necessary, according as great or little con-

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* In copying certain classes of drawings the writer has found that light admitted through a funnel-shaped box, formed of tissue paper stretched on laths, prevents the irregularities of the paper showing. In copying prints from albumenized paper, &c., the same procedure may be followed.

trast is desired The addition of eosine is also to be recommended, in which case the yellow-greens have an advantage. If gelatine plates are stained with a mixture of cyanine blue and eosine, a greater range of colour sensitiveness is attained than by one of these alone. A gelatine plate may be immersed for a couple of minutes in an aqueous solution (faintly coloured) of the two, and then dried. The cyanine must first be dissolved in a slight trace of alcohol, and then the eosine dissolved in water added to it. The other method is to use a gelatine plate as the sensitive medium, and to illuminate the painting by light coming through canary-coloured glass. In this case sun light or electric light may be used. A combination of the two methods is much to be recommended.

For Copying Pictures in plain black and white, a simple iodized collodion is recommended by many skillful photographers. In practice it has been found that a bromo-iodised collodion yielding intense negatives answers well for ordinary work. The addition of a grain or two of pyroxyline (or, better still, papyroxyline) which has been washed in dilute ammonia will often cause a limpid collodion to become fit for copying purposes. The alkaline reaction in collodion gives intensity, and this is further increased by the addition of the pyroxyline. Should a painting, either in monochrome or colours, have to be reproduced, the ordinary bromo-iodized collodion is recommended.

The bath should be free from any impurity, and may be of the ordinary strength.

For plans or line drawings, developers Nos. 1 and 8 (pages 45 and 46) are recommended. The iron may be used even weaker than in No. 1, and may be as follows :—

Ferrous sulphate	5 grains
Glacial acetic acid	10 minims
Alcohol	*quant suf.*
Water	1 ounce.

With a simple iodized collodion, pyrogallic acid may be resorted to as a developer. Should this be decided upon, half the acetic acid given (formula, page 45) should be added, otherwise the deposit may become too crystalline in character. In winter, or when the light is weak, the iron developer should invariably be employed.

Negatives of plans drawn in lines should never be fully developed, and they should be slightly under-exposed. When the reduction on the whites has taken place, the developer should be washed off, and the negative fixed. By this method deposit on the lines is avoided.

The negatives will require intensification. In rare instances the simple application of No. 5 (page 50), followed by the pyrogallic intensifier, will suffice. Should this, however, not give sufficient density, either Nos. 8, 9, 10 or 11 (pages 50 and 51) may be tried in addition.

It requires considerable practice in manipulation to prevent (1st) a stain forming on the lines from the pyrogallic acid intensification, or (2nd) the lines from becoming filled up by a deposit from the intensifier after fixing.

The ordinary procedure of wet-plate intensification should be carried out in copying paintings.

It is safer, after using a solution of mercury, to let the negative dry spontaneously. Rapid drying is apt to cause the film to split.

Collodion emulsion plates may also be used for copying plans, using a preservative such as Colonel Wortley's (125). The intensification may take place by any of the methods given above. Gelatine plates are also to be employed. They may be made by the formulæ given at page 128, omitting the long boiling. The boiling should only be for five minutes. Of course the plates are slower, but they take great density with ferrous oxalate development. It is no use using a plate which gives only feeble images; it is merely waste of time, since no mercury intensification will make them fit to give perfectly black and white prints, which is a desideratum for this speciality. Whatever process is employed, the great desideratum is a bright light.

If the reader be lucky enough to have an electric light, he will be enabled to copy plans even at night with the greatest ease. The following arrangement has worked well with the writer. A common lens, some three to four inches in diameter, is placed near the light in such a manner that it throws a disc of light just larger than the plan to be copied on to it. The light is very intense, and half a minute's exposure should suffice with it. Failing the electric light, if a foot or two feet of magnesium ribbon be burned behind the lens so as to give the same disc of light, a good negative may be taken.

For copying, it is useful to know the equivalent focus of a lens, as by it the distance of a plan, &c., from the lens may be known. To determine it, see Appendix.

CHAPTER XXVI.

PRODUCTION OF TRANSPARENCIES.

The production of positive transparencies on glass from a negative is necessary, as a rule, for the multiplication of negatives, reversed or otherwise. The following are modes of production by the camera or by contact printing.

Camera Transparencies.—When it is determined to use the camera, if a proper copying camera be not at hand, the following substitute may be employed. B is any ordinary rough box, the top of which is removed. Out of one end is cut a rectangular portion, C, just large enough to hold the negative from which the transparency is to be obtained. Small pieces of wire are placed across the angles to support the face of the negative. When the latter is placed in position, a couple of pins inserted at the top and bottom of the outside of the opening will prevent it from slipping. Placed as shown in the figure, the light from the sky being reflected through it by a mirror or by a perfectly smooth sheet of white paper, a transparency may be obtained merely by treating the negative as if it were a plan, &c., to be photographed. It has usually been considered that the

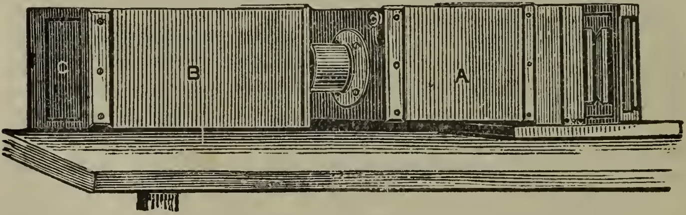

Fig. 22.

box holding the negative and the camera ought to be connected together, no diffused light having access to the front of the negative. In practice this is found unnecessary, and where the negative is dense the diffused light is absolutely an improvement. Should it be found advantageous to exclude all light, a couple of battens placed across the negative, and a cloth thrown over them, will answer the purpose. An opening through the outside wall of the dark-room may be used to hold the negative. A mirror placed at about 45° with the horizon, and covered over with plate glass as a protection from dust and rain, reflects the clear light of the sky through the negative.

It need scarcely be said that the focussing should be very carefully attended to; a common pocket magnifier is useful where extreme definition is to be obtained on the ground glass.

The negative for a brilliant transparency should be slightly less dense than one suitable for good printing. It is, however, by no means to be inferred that a negative of even great density cannot be copied, but only to be understood that the less dense one will give the finest results with the least trouble.

With wet plates a highly-bromized collodion is to be recommended. For ordinary printing-negatives the addition of one grain of bromide to the ounce will suffice; for a negative of the weak type the bromide may be omitted; whilst for a dense negative the bromide may be added up to three grains per ounce if the collodion will bear it. The bromide should be added from five to six hours before the collodion is required.

The exposure should be long enough to cause the minutest detail in the negative to be apparent in the transparency. On drying, the points of bare glass should be very few; if not, it may be taken for granted that the exposure is too short. No fixed rules can be laid down for the length of exposure; the operator must use his judgment.

The development for wet plates is carried on with a very weak developer, the strength varying with the density of the negative to be reproduced; the denser the negative, the stronger the developer should be. For a negative of medium density the following may be used:—

Ferrous sulphate	5 grains
Glacial acetic acid	5 minims
Alcohol...	*quant. suff.*
Water	1 ounce

For a *very* dense negative the ordinary 30-grain iron developer (page 45) may be used. Should there be too much contrast, add more bromide to the collodion, and use a stronger developer; if too little, diminish the quantity of bromide, and use the weak developer. Intensification may be carried on to such a point that on looking through the glass the *deepest* shadow appears nearly opaque.

The transparencies are better fixed with sodium hyposulphite (see page 52), as the delicate details might be eaten away in some slight degree by cyanide.

The ordinary colour given by silver is not an agreeable one, and it is generally necessary to tone the image. This may be effected by a platinum salt, a gold salt, or iridium salt, or by a mixture of any or all of them. The formulæ are as follows:—

No. 1.	—Ten-grain solution of platinum-tetra-chloride	1 drachm
	Nitric acid	12 drops
	Water	10 ounces
No. 2.	—Gold tri-chloride	1 grain
	Hydrochloric acid	6 drops
	Water	10 ounces
No. 3.	—Iridium chloride	1 grain
	Hydrochloric acid	12 drops
	Water	10 ounces

If a mixture in equal quantities by measure of Nos. 1 and 2 be taken and flowed over the plate, a pleasing tone will be given. When toning with gold, a pink deposit is apt to form on the transparent portions, which spoils the effect. Sometimes the platinum solution by itself will give rather an inky colour.

For making prints on opal the wet plate process may be adopted. The image is developed with a developer containing citric acid as well as acetic acid, and if the exposure be right the result is a warm brown tone. In some studios the tone is slightly warmed by toning with ammonium sulphide, which gives a pleasing colour, and is permanent. Gelatino-chloride (which we describe at page 155) may also be used. It gives a brown or a jet black image, according to the developer used, and also whether the emulsion be unboiled or boiled.

Moderately rapid gelatine plates may be used instead of wet plates, in the camera. The development may be with the alkaline developer made with the sulphite of soda, and thus a pure warm, black tone may be obtained. Ferrous oxalate may also be used.

Transparencies by Contact Printing with Dry Collodion Plates.—Transparencies may also be made by placing dry plates in contact with the negative in an ordinary printing-frame. The best results are obtained when the negatives are of good printing density. When feeble, camera printing is most suitable. The exposure may be made by opening the window of the dark room for from half a second to twenty seconds in dull weather, or it may be given by the light from a strong gas jet. With an Argand burner of 12-candle power, and with the frame six inches from it, an exposure of from two seconds to six minutes will be be required, according to the sensitiveness of the plate for the particular light employed. With gum-gallic plates the colour given by development (if double the quantity of gelatine solution be added to the iron) will be generally of a warm black, which needs no toning.

Transparencies by Contact with an Albumen Film on Glass.—The next method is one with which most beautiful transparencies may be produced, and although rather more troublesome than the processes which have been described, is well worth the attention of photographers who may have to make enlargements.

The following are prepared:—

No. 1.—Good and ripe bromo-iodized collodion.

No. 2.—	Albumen from fresh eggs	10	ounces
	Acetic acid	1½	dr.

To prepare this the albumen must be well stirred with a rod, and then allowed to stand twelve hours, when it is filtered through sponge or washed cotton-wool. Next forty minims of ammonia (·880) are added, together with—

Ammonium iodide	60	grains
Ammonium bromide	10	,,

Dissolved in 6 drachms of distilled water.

This kept tightly corked, and in a cool place, will remain fit for use for a couple of months.

No. 3.—	Silver nitrate	480	grains
	Acetic acid	3	ounces
	Water	8	,,

A clean glass plate (given a substratum, see page 91, by preference) is coated with No. 1 in the ordinary manner, and well washed under the tap. It is then coated with No. 2, which is allowed to drain away, carrying with it all superfluous water. No. 2 is again applied, pouring off and on from each corner in succession; and, finally, it is allowed to rest on the plate for a minute, after which it is returned to the bottle. The plate is next set up to dry in a drying cupboard, standing on five or six thicknesses of blotting-paper. When thoroughly desiccated, it is *slowly*, and without stoppage, dipped into a bath of No. 3, and kept in it for from half a minute to a minute (a longer time than the latter is hurtful), and after withdrawal it is washed under the tap for a minute, and finally rinsed with distilled water. An examination of the film will now show if the plate is defective in any particular. Streaks may be removed by a tuft of fine cotton-wool soaked in water and applied gently. It is set up to dry in the drying cupboard, and care must be taken in this drying, as in the last, that it is not touched till thoroughly dry. It is now ready for printing, though a backing (see page 99) may be given it. When in contact with the negative it must be exposed for about fifteen seconds to the diffused light of a clear sky, or longer if the day be overcast.

To develop it, the following solutions should be prepared :—

A.—	Pyrogallic acid	60 grains
	Acetic acid	3 ounces
	Citric acid	15 grains
	Water...	1 ounce
B.—	Silver nitrate	30 grains
	Water (distilled)	1 ounce

After removing the backing, wash the plate under the tap, and flow over it solution A, and return it into the cup, in which have been dropped three or four drops of B. It is well to warm the developing solutions up to about 120° F., as then the image will begin to appear rapidly and evenly. In about twenty seconds the shadows should show, and it should be fully developed in three or four minutes. When any signs of streaks are visible, the plate should be washed and the cotton-wool tuft applied, after which the developing solution may again be flowed over the plate. When the details in the high-lights are sufficiently out, the plate is washed, and is ready for fixing and toning.

The following bath is recommended:—

Sodium hyposulphite	16 ounces
Water	22 ,,
Gold trichloride*	4 grains

The plate is allowed to remain in this bath fifteen or twenty minutes, according to the tone required (a brown tone requiring least time), and is then thoroughly washed for half-an-hour, and allowed to dry spontaneously.

The great difficulty in this process is the liability of the film to blister, but much depends on the kind of pyroxyline used in the collodion. A horny film is sure to blister, whilst one on which you can write your name with a pin without tearing the adjacent parts of the film will probably be found everything that can be desired. Cold in any stage of the operations is a great source of these blisters, hence all the solutions should be kept at a temperature not lower than 70°. This remark applies equally to the fixing solution. If long parallel cracks are formed in the film whilst in the sensitizing bath, the acetic acid is in defect; whilst streaks of unequal density are often due to plunging the plate too rapidly in it. A mottled appearance of the plate after sensitizing is due to the film being too horny. This defect will not occur if the collodion be old, and sensitized, at least partially, with ammonium salts. An excess or defect in exposure is easily recognized by the appearance of the developed image. It is not a bad plan to make the exposure by artificial (such as gas) light of a known intensity.

Transparencies by Contact with a Wet Plate.—Transparencies can be made by contact, or very nearly contact, with a wet plate, by the following plan. A wet plate is prepared in the usual manner; the negative is then placed in the dark-slide with four small pieces of card at each corner; the wet plate is laid on them, and the slide closed. A camera with its lens in focus for a distant object, and with a small stop, is pointed towards a white screen, and exposure given to the wet plate through the lens. The transparency will be found to be perfectly sharp.

Transparencies by Contact Printing with Collodio Citro-Chloride (Simpsontype).—What is usually known as the collodio-chloride process may also be adopted. A glass plate should be albu-

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* This is best dissolved in two ounces of water, and added when dissolved.

menized round the edges, as for dry processes, and is coated with the collodio-citro-chloride (page 221). When dry, the film is fumed by holding it over the mouth of a bottle containing ammonia, and then moving it till the entire surface has received the vapour. The plate is now brought into contact with the negative in a pressure-frame. If strips of paper be gummed on to two of the corners of each plate, it may be examined without danger of loss of register during printing. A tolerable guess may be made of the progress of exposure by opening half the frame and looking through the two plates. It will usually be found that the print on the collodio-chloride does not possess sufficient vigour. The necessary amount is given by flooding it with—

Gallic acid	75 grains
Lead acetate	50 ,,
Acetic acid	2 drachms
Water	20 ounces

To this a few drops of a twenty-grain solution of silver nitrate should be added. When the intensity* is sufficient, the plate is washed, and then fixed with weak sodium hyposulphite. The image may be toned as given above.

Transparencies by Gelatino-Citro-Chloride.—Very beautiful transparencies can be made by contact printing with gelatino-citro-chloride (see page 222). Plates are coated with the emulsion as in the gelatine process (see Chapter XIX.), and printed deeply. They may be toned, but even when merely fixed they have a rich sepia tint, which is not at all displeasing. The fixing bath is that given at page 52.

Transparencies may of course be made by the gelatino-bromide or the gelatino-chloride processes, and need no further remark.

Transparencies by the Carbon Process.—Another method of producing transparencies is by carbon printing. The gelatine is transferred to glass (which has had a slight trace of waxing solution rubbed over it) instead of to the zinc plate. The picture in this case will be reversed,† which is an advantage in mounting, as the ground glass protects the film.

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* The intensity increases on drying, therefore a certain allowance must be made.

† In producing transparencies in the camera, the same reversal may be effected by turning the film side of the negative away from the lens The glass must be absolutely free from flaws to give a perfect result.

Mounting Transparencies.—In mounting a transparency, some translucent substance must be placed behind it. Ground glass is usually employed, the rough surface being placed on the outside. Another better method is to dissolve to saturation white wax in ether. Filter, and to each ounce of solution add another ounce of ether. Flow over the reverse side, and allow to dry. After twenty-four hours the wax will give a beautiful transparency to the picture. In some of Breeze's transparencies a wax solution is poured over the film side of the positive. With all except the carbon and gelatine transparencies, the following may be substituted :—

Flake gelatine	2 ounces
Glycerine	$\frac{1}{4}$ ounce
Water	6 ounces

The gelatine should be allowed to soak in cold water till it is thoroughly swelled, and then dissolved by placing the vessel containing it in hot water. Just previous to use, two ounces of new milk heated to 90° F. should be added to the above amount; the whole should be well stirred together with a glass rod, and sufficient of the mixture poured from a measure or jug through fine muslin to cover the plate, which must have been *accurately* levelled. It should be allowed to set, and then dried spontaneously in a warm room. If the transparency be reversed, the gelatine should be poured on the film side; and when thoroughly dried, the film may be stripped off. The picture may be cut out and bent to any form after varnishing; for instance, lamp-shades may be composed of a set of prints thus produced.

If two hundred grains of zinc oxide replace the milk, we have Mr. Burgess's Eburneum process. The solution, with the oxide added, should be kept warm, and allowed to stand six or eight hours before being allowed to solidify. The frothy top layer, and the bottom layer containing the coarse particles, are removed, and the solution is to be re-melted and poured on the plate as above. About four ounces of solution should cover a 12 by 10 plate.

Lantern Slides.—For mounting lantern slides, masks of a suitable shape should be cut (or they may be bought), and a glass placed over the film. The mask should be between the two glasses, which may be bound together by stout poper or by thick black ribbon.

CHAPTER XXVII.

REPRODUCTION OF NEGATIVES.

In all cases (excepting when the reproduced negative is to be reversed) a rather thin transparency must first be made. Any of the methods given in the last article may be adopted. The transparency is treated in the same way as the negative. From a carbon transparency, however, a negative cannot be made by contact printing, as, being raised in what will be the high-lights, the surface of the dry plate or collodio-chloride film is prevented from being in contact with the picture. It will be noticed that enlarged negatives can be produced either by making an enlarged transparency, or by enlarging the negative from it in the camera. In all cases of enlargement the camera must be employed for one or the other; but it is strongly recommended that the transparency be enlarged, as then only those defects due to the negative are magnified. The one exceptional case where a negative can be reproduced successfully without a preliminary transparency is by the collodio-bromide process. The negative should be placed in the carrier in front of the lens, with the film side outwards. If a dry collodio-bromide plate be used, it is exposed and developed by the alkaline method, the development being carried on to such a point that in the deepest shades the metallic silver is apparent, by reflected light, at the back of the plate.

A trace of fog is not objectionable if the negative to be copied be very dense. *The plate is not fixed,* but dilute nitric acid (one of acid to one of water answers) is poured over the film. This dissolves away the reduced silver, and leaves a negative image formed of silver bromide. The plate is next well washed, and a very dilute solution of ammonia is floated over the film to neutralize any acid, after which it is taken into the light, and developed with the alkaline or ferrous oxalate developer. This reduces the silver bromide to the metallic state, and gives the required negative. The image, if weak, may be intensified with pyrogallic acid and silver.

The same procedure is taken if wet bromide of silver be used. A plate is treated with collodion containing eight grains to the ounce of cadmium or ammonium bromide, or a proportion of each. It is sensitized in an eighty-grain bath for ten minutes, or the forty-grain bath for twenty minutes. After thorough washing, any one of the preservative solutions given for dry plates is flowed over it, and the exposure takes place whilst it is wet. The ordinary alkaline development is then proceeded with, and the remaining operations as above described.

Reversed Negatives.—For photo-mechanical printing, and single transfer carbon printing, reversed negatives are essential. Their production may be divided into three classes:—1st, reversed negatives taken in the camera; 2nd, negatives reversed by reversing the collodion films of the originals; 3rd, reproductions from other negatives.

In the first case, the negative should be taken by means of a reflector, from a flat plate or glass silvered externally.*

The accompanying sketch gives an idea of what is required.

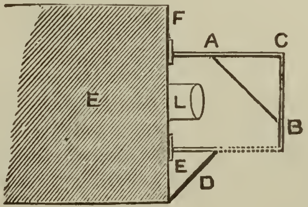

Fig. 23.

E is the camera; L the lens; A C B D is the section of a hood, round which is fitted a flange (FF), which can be screwed into the camera ; A B is a mirror, as above described, which is

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* The mode of silvering the mirrors is given in the Appendix.

placed at an angle of 45° with the axis of the lens, and so adjusted that the centre of the mirror is its continuation; D is a small door, which can be opened or shut at pleasure. The object to be photographed is reflected from A B to the lens, and a little consideration will show that the image will give a reversed negative.

Another plan of obtaining a reversed image is by using a right-angled prism fitted on to the lens.

A A is a flange that fits on the lens, and takes the place of the cap; C C is a right-angled glass prism, whose breadth is equal to or greater than the diameter of the front glass of the lens. All the surfaces are enclosed in brass mounting, excepting C C, care being taken that the surface opposite to the right angle is not in contact with the surface of the glass; E is a shutter for exposure; F F, screws for clamping E. The image undergoes total reflection by the prism, and this gives a reversed negative. There is no particular direction to give in using either the mirror or the prism, excepting that both should be free from dust, and the former from tarnish as well.

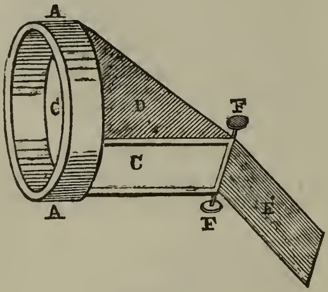

Fig. 24.

An ordinary negative may be reversed by transferring the film. The best method is that of coating it, whilst unvarnished, with a solution of india-rubber in benzole, of the consistency of thin collodion* (india-rubber paste dissolves readily in this menstruum). When drained, it is allowed to dry. Transfer coldion, made as follows, should then be flowed over the surface, and allowed to dry thoroughly:—

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* About one grain to two grains to the ounce.

Ether ·730	5 ounces
Alcohol ·805...	10 ,,
Castor oil	¼ ounce
Pyroxyline	¼ ,,

The plate should then be immersed in cold water for a few minutes, or until the film seems to become loose. Should this not take place in a reasonable time, one ounce of sulphuric acid may be added to each gallon of water, which will aid the detachment. The film should be cut with a penknife round the edges, and should be gently stripped off whilst in the water. It should then be turned over and laid on a clean plate (or one slightly gelatinized) whilst still floating in the water. A soft squeegee, as for carbon printing, may be used to expel the liquid between the two surfaces, and the plate should be set aside to dry, after which it may be varnished and used as an ordinary negative.

Mr. Bolas has worked out a plan for producing reversed negatives by the gelatine process. It is as follows: A gelatine plate is soaked for a few minutes in a 4 per cent. solution of potassium bichromate, and after this it is rinsed for a few seconds in a bath of equal parts of alcohol and water. On removal from the alcoholic bath, it is laid on its back, and a piece of blotting-paper pressed gently against it by a cloth; all superfluous moisture is thus removed, and it is next dried in a warmish place. When dry, the negative to be reproduced is placed under the negative, the exposure being about the same as for a carbon print, say two to four minutes in moderate sunshine, or ten to fifteen minutes in diffused bright light. After exposure the image will be seen impressed with delicate and perfect impression. After rinsing in two or three changes of water the picture is developed by the alkaline or ferrous oxalate developer, and is fixed in the usual manner. The image will be found to be reversed, and to be a negative image. Under-exposure tends to give a flat image, whilst over-exposure gives a hard picture.

CHAPTER XXVIII.

PAPER ENLARGEMENTS BY DEVELOPMENT.

Enlargements on Albumenized Paper.—Albumenized paper should be sensitised in the following bath:—

Silver nitrate	40 grains
Glacial acetic acid	30 minims
Water	1 ounce

and developed with gallic acid.

The gallic acid solution may be made as follows:—

Gallic acid	3 grains
Acetic acid	5 minims
Water	1 ounce

The paper is immersed in a dish of this fluid, and the development takes place rapidly if properly exposed. Remembering that it is a positive print that is required, the purity of the whites must be preserved, and the development stopped before any deposit takes place on the highest light. When properly developed, the print should be taken from the developing dish and *well washed.* Any of the ordinary toning baths will give it an agreeable tone. It should be fixed, as usual, with sodium hyposulphite and water.

Enlargements on Plain Paper.—Plain paper may be salted with—

Sodium chloride	100 grains
Hydrochloric acid	6 minims
Water	12 ounces

Or,

Sodium chloride	6 grains
Potassium iodide	2 ,,
Ammonium bromide	1 grain
Water	10 ounces

The paper is immersed for two or three hours, and then dried. It is then floated for three minutes on the following solution :—

Silver nitrate	1 ounce
Citric acid	8 grains
Water (distilled)	8 ounces

When moderately dry, the paper is pinned on a board, and placed in the camera or its substitute. A *faint* image of the negative should be visible, and then it may be developed by—

Pyrogallic acid	2 grains
Citric acid	1 grain
Water	1 ounce

Sufficient of this must be taken to well cover the paper (which should previously have been stretched on a glass plate by turning the edges underneath it); no stoppage in the flow must be allowed whilst covering the surface. As soon as the proper contrast is obtained, the paper is well washed, and, if necessary, toned. The prints are finally fixed in—

Sodium hyposulphite	1 ounce
Water	16 ounces

They are kept in this till the high-lights lose any trace of colour, when they are withdrawn, and washed in the ordinary manner as for prints on albumenized paper.

Paper prepared by the last formula may also be developed by the ferrous-citro-oxalate developer (page 103), if, after sensitizing, it be washed, and then immersed in a solution of common salt, and again washed (see page 173).

Artistic *enlargements* are also produced by taking an enlarged transparency of the negative, and printing it on ordinary albumenized or salted paper to a depth beyond that ordinarily necessary for silver printing (see "Silver Printing"). The print is then fixed, washed, dried, and waxed, as described at page 171 for the calotype process.

Enlargements on paper may also be effected by the calotype process, and call for no very special remark. A reversed paper positive, enlarged or otherwise, may also be obtained direct in the camera by a process due to Mr. Fox Talbot. Calotype paper is sensitized in the ordinary manner, exposed to light for a short time, then immersed in a weak solution of potassium iodide (about two grains to the ounce answers well), and well washed. It is now exposed in the camera for ten minutes, and developed in the usual way with gallo-nitrate of silver. The resulting picture is a positive, supposing a positive has been copied. The same mode of procedure can be adopted with iodized plates.

(The kind and amount of light admissible for preparing and developing wet and dry plates and paper prints will be found in the chapter relating to the "Dark Room.")

Gelatinized Papers.—There are in the market at the present time two or three gelatinized papers containing silver bromide, and it is to be presumed that these papers are prepared with gelatine emulsion. At first sight, nothing would appear simpler than to coat paper with an emulsion, but we may at once say that it is not by any means so simple as it seems. We will endeavour to give a description, however, of a plan by which it can be accomplished in a satisfactory manner. Firstly, the emulsion may be gelatino-bromide, gelatino-bromo-iodide, or gelatino-chloride, and may be prepared by any of the methods given in the previous chapters. It may be boiled or not boiled, according as great or little sensitiveness is required. For our own part, we like a paper which is only moderately sensitive, since there is no great need to take extremely rapid pictures. One thing, however, we may remark, that with bromo-iodide and bromide emulsions the colour resulting from a boiled emulsion has a tendency to be less green than one prepared without boiling. This remark also applies to gelatino-chloride emulsion, but not with so much force.

The amount of water with which the finished emulsion is made will be found to be about correct; but the operator must, by an experiment with an emulsion, judge whether the gelatine he uses should be increased or diminished. A hard gelatine, for instance, may allow dilution with water. A golden principle to remember is, however, that the thicker you require your film, the less water there should be with the gelatine. If a film is wanted as thick as that for carbon printing, it can be obtained by using 100 grains of gelatine to each ounce of water, instead of about as much to 4 ounces of water. If a thick film, however, be required, we recommend that the operations we are going to describe be repeated twice, or even three times.

The paper to be coated may be medium Saxe paper, or paper of that description with not too high a glaze on it. It should be cut up into the sized sheets required, and carefully dusted from every particle of dust. The emulsion should be heated, and placed in a shallow dish somewhat larger than the sheet to be coated, and the fluid should be a quarter of an inch in depth. The dish must be kept warm by placing it on a closed shallow tin box containing water heated by a spirit-lamp beneath, or some other similar means. When heated to about 130° F. (the temperature depending upon the kind of gelatine employed), the paper is turned up for about a quarter of an inch at one end, and the sheet coiled up in a roll, the coil being made towards the turned-up end. The turned-up end is placed on the emulsion, and the coil gradually allowed to unrol itself, till the whole surface, except the turned-up end, rests upon the emulsion. After resting a minute the end is seized by two hands, and a glass plate having been made to rest on the dish, the uncoated side of the paper is drawn on to the plate, where it remains till it is set,* when it is hung up by clips to dry in a cupboard or other place free from dust. The paper thus prepared should present an even film free from all "ridges" or "tear-markings," and, when developed, should present a vigorous image by transmitted light. To develop a bromide or bromo-iodide emulsion, we recommend a ferrous-oxalate developer, using to every ounce employed about 10 drops of a 20-grain solution of potassium bromide. This gives a blacker image than the ferrous-oxalate alone.

One firm of photographic dealers issued the following directions for developing prints. The following stock solutions were prepared:—

1.—Chrome alum	100 grains
Boiling water	5 ounces

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* It is a good pracaution to take to place a muslin-covered frame over the glass, holding the gelatinized paper to protect it from dust.

2.—Oxalic acid	30 grains
Water	5 ounces
A.—Potassium oxalate	4 ounces
Glycerine	½ ounce
Chrome alum solution (No. 1)	½ ,,
Oxalic acid solution (No. 2)	½ ,,
Water	15 ounces
B.—Ferrous sulphate	4 ounces
Sulphuric acid	10 minims
Water	16 ounces

To develop, 8 parts of A are mixed with 1 part of B.

An excellent developer may be made by mixing equal portions of the ordinary oxalate developer (see Appendix) and the above. For fixing—

Sodium hyposulphite	4 ounces
Water	20 ,,

They further recommend the following for bleaching, if necessary:—

A saturated solution of borax or sulphuric acid	1 ounce
Water	100 ounces

And, to harden the film, common alum (a saturated solution), or chrome alum of a strength 20 grains to each ounce of water.

For a charming black tone we recommend that boiled chloride (page 155) emulsion be used. It is very easily prepared, and presents great facility of development with the ferrous-citro-oxalate developer given at page 103. The bromide and bromo-iodide papers may also be developed with the usual alkaline developer, using citric acid to keep the solutions from discolouring. The addition of sodium sulphite, as recommended by Mr. Berkeley, will answer the same purpose. The fixing bath should be the same as above. When the washing is complete, which will take two or three hours, the prints may be toned if required. A beautiful brown-black tone is given by a weak solution of ammonium sulphide, the colour being permanent. All excess should be well washed out. A solution of sulphuretted hydrogen in water will answer the same purpose. Against the use of such solutions we are aware that many photographers will, metaphorically, hold up their hands, as they will remember the dread they have of bringing any sulphur compounds in contact with a print on albumenized paper. They should recollect, however, that the conditions are totally different. It is the organic compound of silver which gives rise to fading, and not the sulphuration of the metallic silver. Sulphide of silver is about as permanent a silver compound as can exist, and there can be no danger of its fading. Great care must be taken to eliminate all traces of iron salts by washing after development, when using the above solutions, otherwise the white will be dirty. This dirty green appearance, however, may be got rid of by passing the print through dilute hydrochloric acid. The tone assumed by the prints with this treatment is a warm brown black, reaching a jet black if prolonged.

An improvement in the tone may also be given by using the uranium intensifier (see page 153). Resort may also be had to gold and platinum toning; but the above will give almost every variety. If paper be given a coating of india-rubber solution, or gelatine, and then a coating of normal collodion (10 grains of pyroxyline to 1 ounce of ether and 1 ounce of alcohol), the paper may be coated by turning up the edges to form it into a little dish, and holding it on a glass plate. The emulsion is then allowed to set, and eventually hung up to dry.

A plan by which even sheets can be prepared in a small scale is as follows:—A glass plate is cleaned and rubbed with a solution of white wax in ether, and when as much as possible of the wax is rubbed off, emulsion is flowed over the plate to the required thickness, and when well set, a sheet of paper is well damped and squeegeed on to it, and allowed to dry. The film, with the paper adhering to it, can thus be stripped off. A danger in this process is that the particles of bromide or chloride of silver have a tendency to stick to the surface of the plate, and in stripping these particles appear on the surface of the film without any protecting gelatine. If such be the case, fog may be expected. Such paper can, however, be rendered usable by floating for a few seconds on a barely warm solution of gelatine.

With paper the desiccation takes place much more rapidly than with a gelatine plate, since there are two surfaces by which the drying effect of the air is utilized.

For direct enlarged positives, the thinly-coated paper is extremely useful; an optical lantern can be used, and good prints secured with but very short exposure. As an example of the exposure necessary for this, we have produced an enlargement of six diameters by an exposure of three minutes when using a triple-wick oil lamp as the source of illumination. It also should take the place of collodion transfers for working upon in oils or crayons.

CHAPTER XXIX.

THEORY OF SILVER PRINTING.

SILVER chloride, as already has been said, darkens when exposed to the action of sunlight. It assumes a deep violet tint, and, if it be immersed in water, traces of free chlorine will be found to have been liberated. The light then, by its vibratory energy, decomposes the molecule of silver chloride into a sub-chloride and chlorine gas (see page 2).*

Silver chloride is soluble in sodium hyposulphite, potassium cyanide, and also in ammonia. When silver chloride has been acted upon by light, and the sub-chloride formed, the hyposulphite or other fixing agent decomposes it, dissolving the silver chloride, leaving metallic silver. Thus—

$$\underset{\text{Silver Sub-chloride}}{Ag_2\,Cl} = \underset{\text{Chloride of Silver}}{Ag\,Cl} + \underset{\text{Silver}}{Ag}$$

When silver nitrate is brought in contact with an organic substance, the resulting compound is found to be affected by light in a somewhat peculiar way: the compound slowly darkens to a reddish tint; the exact chemical reaction that takes place is very complex to trace, but it may be accepted that an oxide of the organic matter and silver is formed. This oxide is stable,

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* It seems probable, however, that the sub-chloride is subsequently oxidized to a certain extent, and that this oxidation is effected not only by what are called the actinic rays, but also by those which are usually inoperative. This, perhaps, may account for the difference that is perceptible between a print which prints slowly, and one in which the action of light is rapid.

unlike the silver oxide, and is not acted on by fixing agents to any great extent.

If a paper be coated with albumen (say) in which has been dissolved a certain quantity of a soluble chloride, and floated on a silver solution, both chloride and albuminate of silver are formed. It depends, however, on the strength of the solution as to what proportions of each are present, owing to the fact that the organic compound is much slower in formation than the chloride, and has less affinity for the silver. If the silver solution be not sufficiently strong, the chloride may rob that portion of it with which it is in contact of all the silver before any (or, at all events, sufficient) albuminate has been formed, the molecule being composed almost entirely of silver chloride. The stronger the silver solution, the more organic salt will it contain; whilst if it be very weak, very little will be present. Hence it is that with albumenized paper which is weakly salted with a soluble chloride a weak sensitizing bath may be used; whilst if it be rich in the chloride, it must be of proportionate strength.

One other chemical reaction in printing must be considered—viz., that of the free silver nitrate which is always present. During printing, as stated, the silver chloride becomes reduced to a sub-chloride, evolving chlorine gas. This chlorine has a stronger affinity for silver than has the nitric acid (with which it is in combination in the silver nitrate), and, consequently, it combines with the silver, forming new silver chloride,* which, in its turn, enters into a combination with the organic matter, liberating nitric acid.

This freshly-formed chloride, in its turn, blackens by the action of light, and adds to the strength of the image formed. If the free silver nitrate were absent, we should have the chlorine attacking the darkened chloride of silver already formed,† and partially bleaching it. The result would be "measly" or mealy prints—*i.e.*, prints in which minute red spots alternate with darker ones in the shadows after fixing. It will thus be seen that the image of a print is formed by the reduced chloride and also by the organic salt of silver, each playing its part, as

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* Probably together with hypochlorous acid.

† Thus $Ag_2Cl + Cl = 2AgCl$, leaving the organic salt of silver coloured, whilst the sub-chloride of the molecule was bleached.

will be seen in describing the gelatino-citro-chloride process. The organic salt is sensitive to different radiations to those to which the chloride is sensitive; and much depends on the quality of the light as to which salt of silver is most attacked. In daylight which is not rich in ultra-violet rays, we may expect to find the image formed proportionally more by the organic salt than by the chloride of silver, than if the print be made in daylight in which they are largely present. And consequently, after the succeeding operations of toning and fixing, the appearance of the prints in the two cases will be somewhat different.

The most important of the organic substances used in printing is albumen. Hitherto it has been used in preference to any other organic compound, on account of the delicate film it forms, and the beautiful colour the print takes by the production of the albuminate of silver. The albumen should be used fresh, and in a slightly alkaline condition. The principal commercial objection to its employment in such a condition, as the foundation of the picture, arises from the difficulty that is experienced in coating the paper evenly with it. When the albumen gives a slightly acid reaction, paper is easily coated, though toning is retarded, and inferior pictures are the result.

Gelatine frequently forms the sizing of paper. The organic silver compound formed with gelatine gives redder tones than the albuminate.

Starch imparts a more purple tint to the picture than the foregoing. Those papers sized with this substance yield the pictures, on toning, of a bluer tint.

Two kinds of paper are principally used for albumenising—Rives and Saxe. They both are starch-sized papers. The latter is much more porous, and consequently less glossy, than the former. Rives paper is, however, tender when wet, and tears easily when used in large pieces, such as required for large prints. Saxe, therefore, is preferred for large prints, whilst Rives is admirably adapted for *small* pictures where great gloss is requisite. Saxe paper can be rendered nearly as glossy as Rive by doubly albumenising and rolling.

Other papers generally give inferior tones to those above specified, though they are constantly employed.

Toning a Picture.—If a picture printed on albumenized paper or ordinary salted paper (see pages 204 and 205) were at once immersed in the fixing bath, the resulting colour of the image would be of a disagreeable foxy red. In order to remedy this, it is usual to tone the picture by means of a solution of gold.

Supposing a print to be thoroughly washed, and immersed in a dilute solution of gold tri-chloride, the following phenomena would present themselves: the picture would gradually bleach, and a blue deposit would take the place of the more vigorous red image, and, on immersion in the fixing bath, the print would be of a most feeble character. The reason of these changes is this: the chlorine from the gold would attack the silver subchloride, and, while depositing as a metal, would in reality convert the image back to the state of chloride; owing to one atom of gold combining with three atoms of chlorine, the deposited metal would be much less than if the sub-chloride had been split up into metallic silver and chloride by the fixing bath. Thus:—

$$\overset{\text{Silver Sub-chloride}}{3\,Ag_2\,Cl} + \overset{\text{Gold Chloride}}{Au\,Cl_3} = \overset{\text{Silver Chloride}}{6\,Ag\,Cl} + \overset{\text{Gold*}}{Au}$$

In the second case we should have—

$$3\,Ag_2\,Cl = \overset{\text{Silver Chloride dissolved}}{3\,Ag\,Cl} + \overset{\text{Silver left to form the print}}{3\,Ag}$$

In order to avoid loss of vigour, it is usual to add some compound to the gold solution, and in certain cases to leave a small quantity of silver nitrate in the paper. When free silver nitrate is thus present, the compound added to the gold should be a retarder in its action, that when the free nitrate of silver is wholly washed out, the compound should be an active absorbent of chlorine.

As an example of the first case, suppose the lime bath is used (see page 213), where we have a mixture of calcium hypochlorite and calcium chloride; the latter acts as a retarder to the deposit of the gold, as the chlorine from each of these is nearly equally attracted to the silver nitrate. Hence the addition of chloride of lime naturally checks the too rapid deposition of the gold, and the consequent attack on the silver sub-chloride.

As an example of the last case, where all the free nitrate of silver is washed out, sodium acetate has more affinity for chlo-

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* It must not be forgotten that a gold chloride is formed when silver nitrate is added to gold tri-chloride. It is probable that an oxide of gold is first formed, and then finally the metallic gold deposited.

rine than is the silver sub-chloride; hence there is but slight reduction in the depth of the print in fixing.

It has been assumed that the additions to the toning bath cause the formation of an oxy-chloride of gold. This may be the case, though the argument seems somewhat obscure. A simple experiment with stannous chloride added to the gold solution will give proof that the absorption of chlorine alone is necessary.

The theory of fixing the print has already been given in Chapter III. Hyposulphite is used, as cyanide attacks the organic oxide formed by light.

CHAPTER XXX.

PREPARATION OF SENSITIVE PAPERS.

Albumenized Paper.—The following is a useful formula for albumenizing paper :—

Ammonium chloride	100 to 200 grains
Spirits of wine	½ ounce
Water	4½ ounces

When these are thoroughly dissolved, fifteen ounces of albumen* should be added. These ingredients then should be beaten up with a bundle of quills or a swizzle-stick. Constant shaking for half-an-hour in a bottle (holding about double the quantity of mixture prepared) will answer instead.

Having allowed the deposit in the albumen to settle, it is filtered through a sponge placed in a funnel, and from thence poured into a porcelain or other flat dish. The paper being cut into sheets of convenient size, the opposite corners of a sheet, the smooth side underneath, are taken up by the manipulator (one in each hand), and a convex surface is given to it by nearly bringing the two hands together. The middle of the paper first touches the albumen solution, and the corners held by the hand are gradually brought down till the sheet floats on the liquid. The formation of air-bubbles on the surface of the paper is thus prevented, as they are squeezed out. The sheet should

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* The eggs used must be nearly fresh. Each good sized English egg will furnish one ounce, whilst those obtained in the last will only yield five-eighths of an ounce on an average.

remain upon the solution a little over a minute, and then be raised very gradually by one corner, and hung up by two corners* to dry. Should bubbles be inadvertently formed, the paper must be floated again, till a uniform surface is secured.†

When dried, the prepared paper may be rolled, and should be put away flat.

If the paper is floated much longer than stated above, the albumen, being prepared with an alkaline salt, is apt to dissolve the size and sink into the paper, thus destroying the gloss.

Plain Salted Paper.—Prints on plain paper are useful in certain instances. The formula for preparation is given:—

Ammonium chloride	60 to 80 grains
Sodium citrate	100 ,,
Sodium chloride	20 to 30 ,,
Gelatine	10 ,,
Distilled water	10 ounces

Or,

Ammonium chloride	100 grains
Gelatine	10 ,,
Water	10 ounces

The gelatine is first dissolved in hot water, and the remaining components of the formulæ are added. It is then filtered, and the paper is floated for three minutes, following the directions given on the preceding page. If a print on plain paper be required in a hurry, a wash of citric acid and water (one grain to the ounce) may be brushed over the back of ordinary albumenized paper, and, when dried, that side of the paper may be sensitized and printed in the ordinary manner. For cold tones the wash of the citric acid may be omitted.

The Sensitizing Bath.—A good standard for a sensitizing bath is as follows:—

Silver nitrate	50 grains
Distilled water	1 ounce

This solution is suitable for most albumenized paper that is to

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* American clips answer for holding the paper whilst drying. The room or cupboard in which the drying takes place should be kept as high as possible to secure a good gloss.

† For other methods of floating see Hand-book on "Silver Printing" (Piper and Carter).

be obtained in the market when it is required to print from good negatives of a fair density. The paper is floated on the sensitizing solution from about three minutes in hot weather to five in cold. The method of floating is similar to that given above for floating on the albumen solution.

Care should be also taken to withdraw the paper slowly, as the capillary attraction will remove nearly all excess of silver solution, and thus prevent a waste by the droppings, and a loss of time in drying. The paper should be hung up from one corner by an American clip, and a small piece of clean blotting-paper should be attached to the bottom corner to collect the excess of solution. This blotting-paper should afterwards be placed with the paper residues.

After a few sheets are sensitized, the solution will be found to be below strength. It can be roughly tested by the argentometer, which is a float showing a specific gravity of the liquid. The greater the depth of immersion, the lower the specific gravity, and consequently the less salts are dissolved in the water. Supposing that silver nitrate alone were dissolved in the water, the number of grains as indicated by the depth of immersion of the float would give the strength of the solution; but as other soluble matters are likewise to be found in it after paper has been sensitized, it is evidently an incorrect guage. The method given in the Appendix is therefore recommended.

The sensitizing solution, after a day or two, will be found to become discoloured, owing to albumen being dissolved in it. The method of freeing the solution from organic matter is given in the Appendix.

When the sensitized paper is very nearly dry (but not so much as to wrinkle on unrolling it when it is removed from the clip), it should be placed in clean blotting-paper between boards, in order to be flattened for printing.

Should a negative be found very hard, a slight modification of the sensitizing solution will be found beneficial, supposing the ordinary paper is to be used:—

Silver nitrate	30 grains
Water	1 ounce

The negative should in this case be printed in the sun. The more intense the light, the less contrast there will be in the print, as the stronger light more rapidly effects a change in the albuminate than if subjected to weaker diffused light. The reason for the reduction in quantity of the silver nitrate in the solution is given on page 200.

To print from a weak negative, the sensitizing solution should be:—

Silver nitrate	80 grains
Water	1 ounce

The printing should take place in the shade; the weaker the negative, the more diffused the light should be.

If a negative be dense, but all the gradations of light and shade be perfect, the strong bath, and, if possible, a strongly-salted paper, should be used. The printing should take place in sunlight.

With a very weak sensitizing solution the albumen may have a tendency to dissolve from off the paper; the addition of ten to twenty grains of sodium nitrate, or a drachm of alcohol, to the ounce of solution, will prevent the evil recurring.

If the baths be new, and no injurious vapours be present in the air, sensitized paper will keep for a couple of days in hot weather, to a week in cold.

Washed Sensitive Paper.—A method of keeping sensitized paper for longer periods (say for a week or a fortnight) without discolouring has been introduced. It is more sensitive, tones more rapidly, and gives more uniform results than the ordinary sensitized paper; the negatives also may be more than ordinarily weak, and still good prints be obtained.

The paper, sensitized as usual, is passed through, *not soaked in*, face downwards, two or three changes of water,* and hung up to dry. The pads of the pressure-frame must be fumed with ammonia previous to using the washed paper, in order to produce a rich print—the reason, apparently, being that the alkali combines with the liberated chlorine.† Colonel Stuart Wortley's plan of impregnating the pads with ammonia vapour seems the best method of applying it. He places all the pads to be used in a large box overnight, with a little strong ammonia in a

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* All the free silver nitrate must not be washed away, otherwise the print will want depth in tone.

† For further explanation, see Handy-Book on "Silver Printing" (Piper and Carter).

saucer; by the morning they are sufficiently impregnated with ammonia vapour.

The sensitizing bath should not be acid. If a small quantity of silver carbonate* remain at the bottom of the bottle holding the stock solution, the acidity is prevented. A little powdered chalk added to the bottle answers equally well.

Colonel Stuart Wortley uses the following bath for sensitizing paper that is to be washed:—

Silver nitrate	35 grains
Lead nitrate	13 ,,
Sugar	2 ,,
Water	1 ounce

The washed paper may be stored between clean and dry blotting-paper, and pressed between two flat boards. The less air admitted to it the longer it will keep.

Ready Sensitized Papers.—In the market there are two or three ready-sensitized papers, which are printed, toned, and fixed in the usual manner. There is sometimes a slight lack of vigour in the resulting prints, however, which is partially overcome by fuming the pads as described above.

Mr. Hopkins has adopted a method of preserving ordinarily sensitized paper. He floats the sheets of albumenized paper on a 40-grain bath, as usual; then dries till nearly all the moisture is gone. He then places them between sheets of blotting-paper previously impregnated with sodium carbonate solution (about thirty grains to the ounce of water), and allowed to desiccate. The pile of paper he places under pressure, and withdraws the sheets as required.

Another plan of keeping paper in a sensitive condition is by adding from twenty to forty grains of citric acid to each ounce of silver nitrate solution. Many find this to give good results, whilst others find a lack of vigour after toning. The writer has found that if thoroughly washed paper be immersed in a weak solution of potassium nitrite or potassium sulphite it will also keep well, and that the resulting prints will be as vigorous as unwashed paper, or as with washed but ammonia-fumed paper. The fault of the nitrite is its deliquescence. No doubt other salts can be found which are not open to this objection. This

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* The addition of sodium carbonate will form the carbonate of silver.

opens out future possibilities in printing, as the principle which underlies the process is the application of a chlorine absorbent to the silver chloride.

Mr. W. Bedford prepares sensitive paper that will keep by sensitizing on a neutral bath, and then floating the face, whilst still damp, for one minute on a solution of citric acid 30 grains, and silver nitrate 30 grains, to the ounce. Other workers prepare paper to keep by floating the back of the paper on citric acid solution after sensitizing.

Resinized Paper.—To the late Mr. Henry Cooper we are indebted for a valuable printing process, founded on substituting resin for albumen, or other sizing matter. The prints obtained by this process are very beautiful, and lack that gloss of abumen which is often called vulgar and inartistic.

The following are the two formulæ which Mr. Cooper communicated to the writer :—

Frankincense	10 grains
Mastic	8 ,,
Calcium chloride	5 to 10 grains
Alcohol...	1 ounce

When the resins are dissolved in the alcohol, the paper is immersed in the solution, then dried and rolled. The sensitizing bath recommended is as follows (though the strong bath given at page 205 will answer) :—

Silver nitrate...	60 grains
Water...	1 ounce

To the water is added as much gelatine as it will bear without gelatinizing at 60° Fah.

The second formula gives very beautiful prints, soft and delicate in gradation.

The paper is first coated with an emulsion of white lac in gelatine, which is prepared as follows :—

Three ounces of *fresh* white lac are dissolved in 1 pint of strong alcohol, and after filtering and decanting, as much water is added as it will bear without precipitating the lac ; 1 ounce of good gelatine is soaked and dissolved in the pint of boiling water, and the lac solution is added with frequent stirring. If, at any stage of this operation, the gelatine is precipitated, a little more hot water must be added. The pint of lac solution ought, however, to be emulsified in the gelatine solution.

To use the emulsion, it is warmed, and the paper immersed in or floated on it for three minutes. When dry, the coated surface is floated in the following for a couple of minutes :—

Ammonium chloride	10 grains
*Magnesium lactate	10 ,,

When dry, it is sensitized on a moderately strong bath (that given at page 205 will answer).

If more vigour in the resulting prints be required, it is floated on—

Citric acid	5 grains
White sugar	5 ,,

This last bath improves by use, probably by the accumulation of silver nitrate from the sensitized paper.

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* Or ten minims of ammonium lactate.

CHAPTER XXXI.

PREPARATION OF THE NEGATIVE FOR PRINTING.

Skill is required for obtaining the most perfect prints from any negative, and it is only by paying attention to trifling details that the best results can be obtained. It should be remembered that no blind adherence to any rules will attain the object in view; printing requires thought to be exercised, as well as clean manipulation.

Retouching the Negative.—It would be beyond the scope of this work were the manipulations beyond elementary ones necessary for retouching a portrait or a landscape negative. We may say that in retouching a negative it is necessary that it should be illuminated by diffused light from below, and that the surface should be kept as free as possible from extraneous light. A frame, in which is fitted a piece of glass, held by supports at an angle of 45°, may be placed near a window. The light transmitted through the negative, when placed on the frame, may be reflected from a sheet of cardboard, or from a mirror, if the plate of glass in the frame which supports the negative be ground glass. Should the negative be varnished, the parts which have to be retouched should be prepared to give "a tooth" for the pencil, either by rubbing the varnish, where the retouching is to take place, with very fine pumice or resin by a very soft pad, or by the finger. Instead of this the varnish may be made matt by using a drop of turpentine in the same manner. The tooth being given, the deep shadows of the face may be lightened by a judicious stippling with an F pencil; or, if still more opacity is required, by a BB pencil. Stippling may be very well imitated by giving the pencil a circular motion, and taking care that no sharp line is made. Cutting the pencil point to an angle, and using it flat instead of on the point, prevents any danger as regards this. In landscape negatives various small details in the deepest shadows may be strengthened, or even inserted, by a judicious use of the pencil. Should the negative be a gelatine one, it will be found that most surfaces will take the pencil without preparation; if not, they should be varnished. We are not advocates for retouching any negatives, though for portraits some small amount is usually necessary to get rid of defects which are not to be found prominent in the sitter.

Masking the Negative.—Should a picture print too black in the shadows—*i.e.*, attain a bronze colour—before the detail in the lights have printed in, attention should be given to the rules to be found further on, and further improvement may be effected by shading these dark portions. This shading may be done either by temporarily placing a paper, whilst printing, or by gumming tissue paper cut to the proper shape, on the reverse side of the negative. On the deepest shadows two or more layers of tissue paper may be gummed, till the desired effect has been attained. In some cases cotton-wool may be placed over a spot which prints in too quickly; and in extreme cases, where high-lights are wanted, a skilful touch of the brush (using Indian ink or sepia) on the film side may be given, which gives a piquancy to the print which cannot otherwise be obtained.

The prints from landscape negatives frequently show a want of atmosphere in the far and middle distance. In order to give it, the back of the negative should be covered over with tissue paper,* and the shadows in the distance should be made less obtrusive by means of a stump and powdered crayon. The foreground may be caused to approach by heightening its high-lights. A golden rule to remember is, that the greater the distance of an object, the greyer the high-lights, and less heavy the shadows.

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* The paper may simply be gummed round the edges of the negative, or it may be covered with starch and caused to adhere to the whole surface of the back of the plate.

The sky in some negatives prints in too deeply: a mask, cut to the outline of the landscape, and slightly raised from the surface of the negative, will give a graduated sky, which, if left too white, may be subsequently improved by "sunning" down. This sunning down is generally carried out by means of a sheet of non-actinic paper or cardboard, which is moved gently over the picture, leaving the upper portion of sky more exposed to the action of the light than the lower portion, the landscape itself being always completely covered up.

In many landscapes some secondary object may attract the eye by the brilliancy of its high-lights. As the object of all artistic photography is to cause the eye primarily to dwell on the most important point, these bright spots, if they interfere with the effect of the picture, should be sunned down by shading all the print except that particular part. This may be secured by making a brown paper mask, cutting out the shape of the object to be toned down. For this object the negative should be removed, and a clean piece of glass substituted for it in the printing-frame.

Transparent spots in the negative may be touched out on the negative itself. Gum should not be mixed with the paint used, as it is apt to cause the film to split. Opaque spots in the negative are always white in the print, and these can only be touched out on the print after it is fixed and dried.

CHAPTER XXXII.

PRINTING, TONING, AND FIXING.

In toning operations the print loses depth, varying in a great measure according to the toning bath used, and also to the colour to which they are toned. An allowance in the printing should be made for this loss, the picture when taken out of the frame being darker than what it should be when finished. To determine the proper depth of printing is, perhaps, one of the most difficult things in photography. Practice alone can help the student (see "Maxims" at end of this chapter).

After the negative has been placed with the film side towards the back of the frame, a piece of paper the size of the plate should be placed on it. A felt or flannel pad should next cover the paper, and the back be placed over this.

The pad is principally used to cause an equal pressure to be exerted between the negative and the paper. Should the pressure be unequal, the paper will not be in contact at places, which will be shown by a fuzzy appearance at those parts of the print. Even when pads are used, it is not unfrequently the case that this want of contact exists. If the paper has been dried in a moister, hotter, drier or cooler atmosphere than that in which the printing takes place, the presence of the defect need cause no surprise. It is a good plan to let the paper remain in the printing room half-an-hour before printing commences, and to place the sheet of paper on the negative in the frame, with the pad behind it, not pressing down the springs on the back. The negative, of course, should be face downwards on the floor to prevent the passage of light through it. After five minutes or so, the paper will have contracted or expanded sufficiently to enable complete contact to be maintained.

A great source of defective prints is their examination during printing. The frame should never be opened except in very subdued light, otherwise the whole exposed surface of the print may become discoloured, and the purity of the whites lost.

When prints are removed from the frames, they should be stored in a dark box, or between leaves of clean red blotting-paper in a large book.

Toning the Picture.—The following toning baths are found to give good results. No. 1 is found to be very stable, and to give brilliant results:—

No. 1.—	Gold tri-chloride	2 grains
	Chlorinetted lime (chloride of lime)	2 ,,
	Chalk	1 teaspoonful
	Water	16 ounces

If the water be hot, the bath may be used when cool; if not, a day should elapse between mixing and using it.

No. 2.—	Sodium acetate	30 grains
	Gold tri-chloride	1 grain
	Water	10 ounces

To be mixed the day before it is used.

No. 3.—	Chloride of lime	45 grains
	Gold tri-chloride	45 ,,
	Chalk	45 ,,
	Sodium acetate	180 ,,
	Water	15 ounces

(These to be mixed together, without filtering, from seven to fourteen days before use. When required to use, filter out one ounce of solution, to which add eleven ounces of water.)

No. 4.—	Gold tri-chloride	1 grain
	Sodium carbonate	10 grains
	Water	10 ounces

May be used immediately.

No. 5.—	Borax	100 grains
	Water	10 ounces
	Gold tri-chloride	1 grain
	Water	10 ounces

These are mixed in equal parts immediately before use. It is well to prepare the borax by means of heat. This bath is excellent for most of the ready-sensitized papers found in the market. Sixteen ounces should tone the whole sheet of paper.

Other toning baths have been employed, but the foregoing are the principal used with albumenized paper.

Nos. 1, 2, and 3 will keep indefinitely. When the bath becomes inactive from lack of gold, it may be strengthened by a solution containing only one ounce of water to the above quantities of the other ingredients. Nos. 4 and 5 can only be used on the day they are made.

According to the minuteness of the grains of gold, so will it assume, by reflected light, colours varying from purple to a dirty-green. The organo-chloride of silver appears through this layer of gold, and the colours of the two mingling together give the different tones in ordinary prints. When a print is overtoned it becomes blue. This is due to the greater amount of gold deposited over the surface of the silver. The change in colour on the immersion of a print in the fixing bath is due to the solubility of the silver chloride.

With all the toning baths, excepting Nos. 2 and 5, a little of the free silver nitrate should be allowed to remain in the print—that is, before being immersed in the toning bath, the prints should not be too thoroughly washed (see page 202); whilst with the acetate bath it can be shown that all the soluble silver salt should be eliminated. In the first case, the prints should be washed in two changes of water, and the last change should show decided milkiness.* The paper is immersed in the water, with the albumenized face downwards, in order to prevent the silver chloride or carbonate (that may be formed from the soluble chlorides, or carbonates in the water) being precipitated on the surface of the print, and the gold being deposited thereon. Should there be a deposit on the print, it is dissolved away by the fixing bath, and leaves minute untoned spots.

The dish for toning should be sufficiently large to contain a couple of prints side by side, but no more should be immersed than can be conveniently turned over without risk; eight or nine medium-sized prints are generally found sufficient. The dish should be given a continuous and gentle rocking motion to cause

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* The milkiness is due to chlorides, or carbonates, or sulphates.

the solution to flow over and between all the prints immersed, and thus is prevented the adhesion together of any two prints, and the consequent want of tone on those parts which have been in contact. A print must be toned a little deeper than it is intended to remain; for black tones a slight blueness must be perceptible. In all cases, however, *it should possess a rich colour before fixing.*

For resinized paper, Mr. Cooper recommended the following toning bath :—

Solution of gold tri-chloride (1 gr. to 1 dr. of water)	2 dr.
Pure precipitated chalk	a pinch
Hot water	10 ounces

Two dr. of sodium acetate are to be placed in the stock-bottle, and the above solution filtered on to it. This is made up to 20 ounces, and is fit for use in a few hours; but it improves by keeping.

In commencing to tone, place a few ounces of water in the dish, and add an equal quantity of the stock solution, and if the toning begins to flag a little, add more of it from time to time.

With the resin processes over-toning is to be carefully avoided.

Fixing the Print.—The usual strength of the fixing bath is—

Sodium hyposulphite...	4 ounces*
Water	1 pint

Between toning and fixing it is well to wash the prints slightly, in case there should be any trace of acidity in the liquid adhering to them. After taking them out of the toning bath they should be placed in a dish of water, face downwards, till a batch is ready for fixing.

It will be noticed that the toning action on the print continues during this washing, presumably by the solution of gold contained in the pores of the paper continuing to deposit. The addition of a small quantity of common salt has been found useful to stop this action. If this precaution be not taken, the prints first toned should be redder than it is intended they should remain. The action can also be arrested by acidifying the water. This is dangerous, as the presence of acid in the fixing bath causes a speedy decomposition of the hyposulphite.

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* One ounce of sodium hyposulphite will fix *with safety three sheets of paper.*

The prints should be immersed in the fixing bath for twelve or fifteen minutes,* and the solution should be kept in motion during the whole time of fixing, as for toning. Care should be taken to brush off all bubbles that may cling to their surfaces, as the cushion of air impedes the access of the liquid to the silver salt beneath.

When the prints are fixed they will appear colourless in the whites, and free from red patches in the dark portions.

In some establishments it has been found advantageous to add a drachm of ammonia to each pint of fixing solution. The ammonia aids the rapidity of fixing, and neutralizes any acid that inadvertently may find its way into the solution; it also attacks the size of the paper, dissolving it out from the paper in a great measure. This renders the subsequent washing more thorough, and is found, in most instances, to prevent "blistering," which is common with so many albumenized papers.

The prints should he withdrawn slowly from the bath—in order that all excess of the hyposulphite solution may be drawn from them by capillary attraction—and placed in a trough of water, where they should soak a quarter of an hour. They should then be removed, and placed in a stream of running water for twelve hours. If running water be not attainable, a good plan is to place the prints in a dish, changing the water every half hour for five or six changes, and sponging all the moisture out with a thoroughly washed sponge as far as possible after every second change. By this procedure the hyposulphite is very perfectly eliminated. Prints washed in this manner have remained unaltered in colour for the last seventeen years in the writer's experience, having passed through climates dry and moist, and varying in temperature from 20° to 110°.

It is sometimes useful to test the water for sodium hyposulphite after the last washing, in order to ascertain if its extraction is complete. Make the following test solution:—

Potassium permanganate	2 grains
Potassium carbonate	20 ,,
Water	1 quart

The addition of a few drops of this rose-coloured solution to a pint of water will yield a slightly pink tinge. If there be any

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* The thicker the paper the longer the time of immersion.

trace of sodium hyposulphite present, the colour will be of a greenish hue.

If the permanganate be not at hand, the following well-known starch iodide test may be adopted.

Take about two drachms of water and a small piece of starch about the size of a small pea, powder, and boil the starch in the water till the solution is quite clear; add one drop of a saturated solution of iodine in alcohol to this clear liquid. It will now become dark blue. Of this solution drop two drops into two clean test-tubes, and fill up one with distilled water, and the other with the water to be tested; a faint blue colour should be perceptible in the first test-tube. In the second test-tube, should hyposulphite be present, this blue colour will have disappeared, the iodide of starch becoming colourless in its presence. The best mode of comparing the two waters is by placing a piece of white paper below the test tubes, and looking at the paper through the length of the test-tube.

It frequently occurs that though sodium hyposulphite cannot be detected in the washing water, it may be present in the paper itself. The paper on which most prints are taken being sized with starch, if a *very* weak solution of potassium iodide be applied with a brush across the *back* of a print, a blue mark will indicate the *absence* of the hyposulphite, iodide of starch being formed. Care must be taken that the iodide solution is *very* weak, otherwise a part of the iodine will first destroy the trace of the hyposulphite, and then the remainder will bring out the blue re-action.

The dishes used for *toning, sensitizing, and fixing should be used for no other purpose* than that to which they are originally allotted. A porcelain dish on which the glaze has cracked should be rejected for the sensitizing dish, and for the fixing dish. In the first case, the porous porcelain absorbs a vast quantity of silver nitrate; and in the latter, of old fixing solution, which is *very* apt to cause yellow markings on the prints.

Tin dishes should be avoided in all cases. The tin corrodes, and marks the picture. Perforated zinc is often used for the bottoms of washing troughs. This also should be avoided, as after a time it becomes fouled, the sodium hyposulphite acting upon it, and the prints get stained where they touch it.

Maxims for Printing.

1. The print should have the highest lights *nearly* white, and the shadows verging on a bronzed colour before toning.

2. Print in the shade, or direct sunshine, according to the density of the negative.

3. Place the prints, before toning, in the water, face downwards, and do not wash away too much of the free nitrate of silver (see exception, page 216).

4. The toning solution must be neutral or slightly alkaline, and not colder than 60°.

5. Tone the prints to purple or sepia, according as warm or brown prints are required.

6. Move the prints in both the toning and fixing solutions, repeatedly, taking care that no air-bubbles form on the surface.

7. Take care that the fixing bath is not acid.

8. Use fresh sodium hyposulphite solution for each batch of prints to be fixed.

9. Wash thoroughly *after* and *before* fixing.

10. Make a sensitizing bath of a strength likely to give the best results with the negatives to be printed; a weak negative should be printed in a feeble light, and a dense negative in sunshine.

CHAPTER XXXIII.

DEFECTS IN PRINTS.

Defects in Prints.—Small white spots, with a black central pin-point, are often met with in prints. Dust on the paper during sensitizing will cause them, the grit forming a nucleus for a minute bubble. All paper should be thoroughly dusted before being floated on the sensitizing bath.

Grey, star-like spots arise from small particles of inorganic matter, such as a ferric oxide, lime, &c., which are present in the paper. They become more apparent by decomposition during the printing operations. They may generally be discernible by examining the paper by transmitted light.

Bronze lines (straight) occur through a stoppage during floating the paper in the sensitizing solution. Should the lines be irregular, forming angles and curves, it is probable that a scum of silver oxide, &c., may be detected on the surface of the sensitizing solution. A strip of blotting-paper drawn across the bath will remove the cause of the defect.

Should the print appear marbled, it may be surmised that the sensitizing solution is weak, or that the paper has not been floated sufficiently. In some cases it may arise from imperfect albumenizing; but in ordinary commercial samples the cause can be easily traced.

Red marks on the shadows may appear during toning, and are very conspicuous after fixing. They generally arise from handling the paper with hot, moist fingers after sensitizing; greasy matter being deposited on the surface, prevents the toning bath acting properly on such parts.

Weak prints are generally caused by weak negatives. Such can be partially remedied by paying attention to the strength of the sensitizing bath (as shown in page 206), and by using washed paper.

Harsh prints are due to harsh negatives. They are generally to be remedied by paying attention to the mode of printing given at page 217. If the negative be under-exposed and wanting in detail, there is, however, no cure for this defect. When the high lights appear too strong, it is not a bad plan to subdue them by sunning the print through the paper.

A red tone is due to insufficient toning; whilst a poor and blue tone is due to an excess of toning.

The whites may appear yellow from imperfect washing, imperfect toning, imperfect fixing, or from the use of old sensitized paper.

Should prints refuse to tone, either the gold has been exhausted, or else a trace of sodium hyposulphite has been carried into the toning bath by the fingers or other means. A trace of hyposulphite is much more injurious to the print than a fair quantity of it. Should the toning bath refuse to tone after the addition of gold, it may be presumed that it is contaminated by a trace of sodium hyposulphite.

A dark mottled appearance in the body of the paper indicates imperfect fixing, combined with the action of the light on the unaltered chloride during fixing. If the fixing bath be acid, the excess of acid combines with the sulphur, and forms hydrosulphuric acid, which will also cause the defect.

The cause of mealiness or "measles" in the print has been explained in page 200.

Blisters are sometimes found during washing, after fixing, beneath the surface of strongly albumenized paper. These arise from a strong saline solution being shut in behind the albumen, which is afterwards in contact with simple water. By putting a little common salt with the first wash water this defect may often be avoided.

CHAPTER XXXIV.

COLLODIO- AND GELATINO-CITRO-CHLORIDE PAPER.

The Collodio-Citro-Chloride Process was introduced by Mr. G. Wharton Simpson. Primarily, it was described for printing on glass or paper, and for such it is given here.

The collodio-chloride is formed as follows:—

*No. 1.—	Silver nitrate	1 drachm
	Distilled water	1 ,,
No. 2.—	Strontium chloride	64 grains
	Alcohol	2 ounces
No. 3.—	Citric acid	64 grains
	Alcohol	2 ounces.

To every 2 ounces of plain collodion add 30 drops of No. 1, previously mixed with one drachm of alcohol; then add one drachm of No. 2, shaking well at the same time; lastly, half a drachm of No. 3 solution. In a quarter of an hour it is fit for use. There is sometimes a difficulty found (especially when applying the collodio-chloride to glass), due to the crystallization of the salts on the surface of the film. The writer has entirely overcome it by using the above proportions, substituting 72 grains of ammonium citrate for the citric acid, and then washing the emulsion thus formed in a similar manner as directed for the bromide emulsion (see page 123). It is, however,

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* The formulæ are taken from the Year-Book of Photography for 1871.

necessary to add a small quantity of silver nitrate, after redissolving the collodion pellicle in the proper proportion of solvents; about 8 grains to the ounce of emulsion is the amount recommended. If, however, the paper or plate be immersed in a solution of—

Potassium nitrite	20 grains
Water	1 ounce

the silver may be entirely omitted, and a vigorous image will result. The reason of the addition of the nitrite is the same as that given for adding it to washed paper (see page 208).

The above formulæ apply to printing on paper, or on glass, porcelain, &c.

The paper best adapted for the reception of the collodio-chloride is arrowroot paper, or enamelled paper, such as is used for heliotype or lithography. A paper rather larger than the size of print required is taken, the edges turned up for one-eighth of an inch all round to form a tray, leaving a small spout at one corner. This paper is then placed on a glass plate, and is coated in a dark-room with the emulsified collodion, and allowed to dry. It may be found to increase the brilliancy of the resulting print to pin it on the inside of the lid of a large box, and to expose it to the fumes of a drachm of ammonia poured into a saucer, though this is unnecessary when the potassium nitrate is used.

The print is taken in the ordinary manner, and may be toned by any of the ordinary toning baths, the lime bath (No. 1, page 214) being the best, providing it be old.

The following toning bath, made in two separate solutions, gives rather inky tones:—

No. 1.—	Ammonium sulphocyanide... ...	1¼ ounces
	Sodium hyposulphite	45 grains
	Sodium carbonate	15 ,,
	Water	50 ounces
No. 2.—	Gold tri-chloride	30 grains
	Chalk	1 teaspoonful
	Water	50 ounces

Equal quantities of these are taken and mixed, and the toning proceeds as usual. The prints ordinarily take from two to ten minutes to tone. If a longer time be required, add more gold till the desired effect is produced. This toning bath can only be used once.

Gelatino-Citro-Chloride.—The writer has introduced a process of printing by means of a citro-chloride in gelatine, which can be applied to paper and glass. The method of preparation is as follows:—

1.—	Sodium chloride	40 grains
	*Potassium citrate...	40 ,,
	Water	1 ounce
2.—	Silver nitrate	150 grains
	Water	1 ounce
3.—	Autotype gelatine...	160 grains
	Water	3½ ounces

Nos. 3 and 2 are mixed together, and then an emulsion formed by adding No. 1 in the usual way when forming a gelatine emulsion. When set, the emulsion is squeezed through canvas into cold water (see page 134), and after allowing it to remain in the water for ten minutes or a quarter of an hour, dissolved up, with the addition of about 3 drachms of alcohol and 2 grains of chrome alum dissolved in 2 drachms of water. Plates or paper are then coated with the emulsion, and printing takes place in the usual manner. At first the emulsion may appear grainy; if, however, it be boiled for ten minutes, the grain disappears, for the silver citrate is soluble in warm water. The rapidity of printing by the boiling is certainly increased. Plates, when coated, are rather transparent, and, *prima facie*, a vigorous print might not be expected from them. The rapidity of printing is very great; it is more than twice as rapid as ordinary albumenized paper. The image prints of a violet tint by reflected light, and of a rich chocolate colour by transmitted light. If fixed without toning, the colour by transmitted and reflected light is burnt sienna colour, and of great vigour and beauty. Prints can be toned by any of the ordinary toning baths. Borax and chloride of gold (see page 215) gives a pleasant tone; the sulpho-cyanide toning bath (page 224) gives a black, rather approaching an inky tone. Platinum can be used to tone the fixed print, but it has a great reducing action, and there is a

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* The citrate may be reduced to 20 grains, and the silver nitrate to 120 grains.

tendency for the whites to become yellowed to a slight extent. No doubt endless variations in the organic salts used might be made, but the citrate answers well.

The prints should be well washed. It is believed that they would not fade in the same way that albumen prints are so prone to do, as the organic salt used is a definite compound, and not one which is so complex and uncertain as the albuminate of silver is. The liability to fade is less with the above formula than with one which has an excess of silver present. The potassium citrate is in large excess; hence no silver will attack the gelatine. As regards the light to which these citro-chlorides are sensitive, a reference to fig. 25 will show the advantage they have over the chloride; No. 5 is the spectrum printed on silver chloride, and No. 6 that on the organic compound and chloride. As the ultra-violet rays of the spectrum which lie beyond H are deficient in winter, these papers should print quicker than extra ordinary albumenized papers, since they are sensitive to the green ray.

Fig. 25.

The top letters refer to Fraunhofer lines; the bottom letters are the initials of the colours. The height of the curve denotes the relative sensitiveness to the different colours.

Fixing Bath.—The fixing bath for both the above papers is composed as follows:—

Sodium hyposulphite...	1 ounce
Water	30 ounces

The print should be immersed in this for about eight minutes.

CHAPTER XXXV.

PRINTING WITH SALTS OF IRON AND URANIUM.

THE basis on which these processes are founded is that the ferric and uranic salts are reduced to the ferrous and uranous state by the action of light. Thus ferric chloride throws off one atom of chlorine, and becomes ferrous chloride.

The most ready process for obtaining prints from a negative by an iron process is that originated by Sir John Herschel, in which the double ferric citrate and ammonium citrate are the sensitive agents. To prepare this salt, precipitate ferrous sulphate (*after thorough boiling with nitric acid*) by ammonia, and wash the oxide by decantation. Next make a saturated solution of citric acid, and add it to the oxide till it is nearly all dissolved; but note how much citric acid solution has been employed. Take an equal quantity of this same solution, and neutralize it carefully with ammonia, testing with litmus paper, and mix the two solutions.

Dilute this solution to half the bulk, and, after filtering, float plain paper on it. When dried, it may be exposed beneath a negative in the sunlight for two or three minutes, or in good diffused light for a quarter of an hour.

These prints require development, which may be effected by immersing them in a solution of potassium ferri-cyanide, which will give blue prints. They are fixed by slightly acidulating the first wash water with hydrochloric acid, and then thoroughly washing in ordinary water.

A silver print may be obtained by floating the print, after exposure, on a dilute solution of silver, which will be partially reduced by the ferrous compound produced by the action of light, and then applying gallic acid and silver (see page 192) to intensify the image. In this case, it is well to fix with sodium hyposulphite, and to wash as usual.

A print may also be formed in metallic gold by brushing over the exposed paper a dilute and neutral solution of gold trichloride.

To fix these last prints they should be immersed in water slightly acidified with hydrochloric acid, and be then thoroughly washed.

"*Blue*" *Printing Process.*—Another plan by which prints can be made direct without development, is based on the fact that if ferri-cyanide of potassium and a ferric salt be mixed together, and spread on paper and dried, light changes the mixture into an insoluble blue matter, partaking of the nature of Prussian blue. The following solutions answer well:—

Potassium ferricyanide	2½ ounces
Water...	10 ,,
Ammonio-citrate of iron (ferric salt)	2½ ounces
Water...	10 ,,

The two solutions are dissolved separately, and are then mixed. The solution should be preserved in the dark. To prepare paper, a smooth-surfaced drawing paper is covered with the mixture by means of a sponge, the strokes of the sponge being crossed so as to obtain as even coating as possible. The surface often looks streaky, but it is not of much consequence, as long as the paper is actually covered with the mixture. The paper is not used within three or four days of its preparation. When dry, the paper is used in the ordinary manner and exposed to light, the printing taking place in five or six minutes, that necessary for a silver print. A print fully exposed should take a bronzed appearance. The exposed paper is next placed in a dish or tray of water, and a sponge may be used to aid the elimination of the soluble salts from the surface of the paper. When the wash water is no longer tinged with yellow, the print is sufficiently washed, and has only to be hung up to dry. If drawings or tracings have to be multiplied, they should be exposed with their backs to the sensitive surface, in which case there is no reversal of the image. This process gives *white lines on a blue ground.*

Cyanotypes or Positive Pictures from Positives.—To obtain positive pictures from a positive, a slight modification of the above must be made.

Thirty vols. of gum solution (water 5 parts, gum 1 part) are mixed with 8 vols. of a solution of citrate of iron and ammonia (water 2 parts, double citrate 1 part), and to this is added 5 vols. of a solution of ferric chloride (water 2 parts, ferric chloride 1 part). This is limpid at first, but gradually grows thicker, and should be used soon after mixing. It is applied with a brush to well-sized paper, and dried in the dark. Any design or drawing can be copied by a few minutes' exposure, when it is developed with—

Potassium ferrocyanide	50 grains
Water	1 ounce

This is applied with a brush, and the picture appears of a dark blue. As soon as every detail has appeared, the print is rapidly rinsed, and put in a dish of hydrochloric acid—

Hydrochloric acid	1 ounce
Water	10 ounces

The image becomes clearer and the background whiter. The details of this process are due to Captain Pizzighelli, of Vienna, and is something like Pellet's process.

According to Dr. Liesegang, Pellet's process, which is a secret, is as follows. The following solution is made:—

Common salt	3	ounces
Ferric chloride	8	,,
Tartaric acid	$3\frac{1}{4}$	,,
Water...	100	,,

First dissolve 25 ounces of powdered gum-arabic in half the water, and dissolve the ingredients in the other half. This mixture is applied with a brush to strongly-sized and well-rolled paper in a subdued light. The coating should be as even as possible. The paper should be dried rapidly to prevent the solution sinking into the pores of the paper. When dry, the paper is ready for exposure. In sunlight one or two minutes is generally sufficient to impress an image; while in a dull light as much as an hour is necessary. To develop the print, it is floated immediately after leaving the printing frame upon a saturated solution of potassium ferro-cyanide; none of the developing solution should be allowed to reach the back. The development is usually complete in less than a minute. The paper may be lifted off the solution when the face is wetted, the development proceeding with that which adheres to the print. A blue colouration to the background shows insufficient exposure, and pale blue over-exposure.

When the development is complete, the print is floated on clean water, and after two or three minutes is placed in acidified water made as follows:—

Sulphuric acid	3 ounces
Hydrochloric acid	8 ,,
Water	100 ,,

In about ten minutes time the acid will have removed all iron salts not turned into the blue compound. It is next thoroughly washed and dried. Blue spots may be removed by a 4 per cent. solution of caustic potash. These prints show blue lines on a white background, supposing a tracing to have been used as the shield to light. The back of the tracing must be placed in contact with the sensitive surface. This process depends on the fact that ferric salts form a modified Prussian blue when treated with potassium ferro-cyanide. The gum in this process and in that of Pizzighelli is used to prevent the staining of the background. The best results are often obtained by printing through the paper, in which case the tracing to be copied should be placed with its face to the back.

Uranium Prints.—To print with uranium the following sensitizing bath may be employed—

Uranic nitrate	80 grains
Water	1 ounce

The prints may be developed by the first three developing solutions given for developing the iron prints. With the first one we have a very brown print, with the next the greyish one due to the colour of deposited metallic silver, and with the last the purple tone due to metallic gold.

CHAPTER XXXVI.

THE PLATINOTYPE PRINTING PROCESS.

This process is the subject of a patent, and was invented by Mr. W. Willis. It is essentially an iron process, and depends, firstly, on the fact that ferric oxalate is reduced or converted into ferrous oxalate, and also on the discovery made by Mr. Willis that ferrous oxalate, when dissolved in a hot solution of potassic oxalate, instantly reduces the metal from chlorides and other salts of platinum, more particularly when in the platinous state.

Now, suppose a platinum salt, such as chloro-platinite of potassium, K_2PtCl_4, is mixed with the ferric oxalate with which paper is coated, upon exposing such paper to light the ferric salt only will be affected, being changed into ferrous salt; but the particles of this ferrous salt will be in contact with the platinum salt. If, now, this insolated paper be floated on a hot solution of potassic oxalate, its ferrous image will be dissolved by the potassic oxalate, but at the moment of solution it will reduce, *in situ*, some or all of the platinum salt so intimately mixed with it, and the result is a picture in pure metallic platinum black. Metallic platinum is one of the most stable substances known to chemists, perfectly unalterable by any atmospheric influences, not oxidized in the air at any temperature, and not attacked by any single acid or alkali.

Coating the Paper.—To coat paper the following is used:—A solution of ferric oxalate, in each ounce of which 60 grains of potassic chloro-platinite are dissolved without the aid of heat.

The Platinotype Company supply paper specially prepared for the purpose of coating, but we have succeeded by floating ordinary Rive paper with a solution of gelatine of about 10 grains to the ounce. We have also succeeded with paper sized with arrowroot. The following directions are issued by the Company for sensitizing:—

Suppose it be wished to sensitize a surface of paper measuring 8 by 10 or 15 by 12, the simplest method is to place a piece of paper of sufficient size, with its prepared surface uppermost, upon an 8 by 10 or 15 by 12 glass plate, and then to fold the edges of the paper underneath the plate. By placing the plate upon a table (or, better, on a glass plate of larger size), the edges of the paper will be securely held between the plate and the table, and a smooth surface will be secured. The paper must be larger than the plate, to allow its edges to be turned over. Another method of securing a smooth surface is to place the paper on a glass plate of the same dimensions as the paper, and then to clip together the corners of the plate and the paper by means of American clips. Yet another method, which frequently answers well, is to pin the paper by its corners to the smooth surface of a deal board. By the last two methods the corners of the paper are lost, which is not the case with the first method.

The sensitizer is now applied to the surface by means of a pad of cotton-wool, or, better, by a pad made by enclosing a tuft of cotton-wool in a small piece of flannel or old gauze underclothing.

To coat a surface measuring 8 by 10, from 25 to 30 minims of sensitizer will be required. This quantity should be measured and then poured on the middle of the sheet of paper, and immediately spread over the surface with a circular motion, in as even a manner as possible, by means of the above-described pad. The rubbing should be very gentle, and should be continued until the coating becomes as uniform as possible.

Drying the Paper.—Success much depends on the care with which this operation is performed; the instructions here given should be strictly adhered to.

As soon as the sheet has been coated it should be hung up by one or both of its corners (on no account should it be laid over a rod) until the surface-moisture has disappeared. Directly this has taken place, the sensitized surface should be dried before a fire or stove, or over a gas-burner. It is of the utmost importance that the paper be *perfectly* dried. The drying point is indicated by the change in colour of the surface, which changes from lemon to orange yellow, and by the crackling sound of the paper. Great care should be taken not to scorch the surface. A scorched sensitive surface gives grey, fogged prints.

It is important to allow a sufficient, but not too long, time to elapse between the coating operation and that of drying. Not less than five, nor more than ten minutes, should be allowed to elapse between these operations. If paper be dried too soon, too large a portion of the platinum image will wash off in the developer. If not dried quickly enough, the print will be sunken-in and flat.

In very dry weather, particularly in some climates, the surface-moisture will disappear too rapidly, that is, in less than five minutes; in such a case, the atmosphere of the room in which the paper is hung up should be moistened by sprinkling the floor or walls with water, or the paper may be placed in a damping box or cupboard.

Directions for storing, exposing, and developing, will be found in the instructions for printing.

The paper is now ready for exposure under a negative.

When the paper is placed on the negative it is well to place behind it a sheet of vulcanized india-rubber sheeting or a piece of well waxed paper, to prevent any damp from the pads affecting the paper during printing. The time of exposure necessary to give to a print depends naturally on the negative; but it is about one-third of that necessary to give to a silver print. We may state that the process is most successful with negatives of fair density; though by careful manipulation in development almost any negative may be made to yield fair results. Hard negatives require, for instance, a greater heat of solution in development than negatives in which the contrasts, though well marked, are yet not too intense. There is a peculiarity about most ferric salts, which is, that after a reduction by light to the ferrous state, a still further reduction is caused by continued exposure, and this is almost equivalent to the reversal of the image in a negative. Thus, if an iron-coated paper be exposed to the spectrum till a faint impression is made on the paper, and is then developed with ferricyanide of potassium or auric chloride, the colours which are absorbed by the iron salt leave their impressions in varying degrees of intensities. If, however, the exposure be very prolonged, the place of maximum sensitiveness will not develop, but remain white, or be but little coloured, the rest of the spectrum developing properly. If the developing solutions be used hot, this bleaching will not occur nearly so readily. For this reason, then, with a hard negative, where the whites are properly printed, the shadows may show slight reversal. To overcome the reversed action a hotter development is advisable. This reversed action can be seen on the print itself; the lemon colour of ferric oxalate first gives place to orange colour, and where this reversed action is suspected, the orange tint will be lighter than in the parts less exposed. The exposure may be timed by an actinometer (see Heliotype and Carbon Processes), or can be judged of by examining the print in a very feeble light.

Developing the Print.—Development may take place in a moderately subdued white light. The developing solution is as follows :—

Oxalate of potash (neutral) ...	1,300 grains
Water	10 ounces

This solution, when made, is conveniently used in an enamelled iron dish supported over some source of heat, such as a Bunsen burner or spirit lamp, to enable it to be kept at a temperature of between 170° and 180° F., which is the normal temperature. The depth of fluid in the dish for development should never be less than ¼-inch. The developing solutions may be used over and over again, decanting it from any green crystals which may be deposited in the bottle, and adding fresh solution from time to time. The development takes place by floating the paper on the hot solution in the manner prescribed for albumenizing paper (page 204); or if the paper be longer than the dish, but narrower, it may be slowly dragged over it somehow. In every case the development should be full.

Cleaning and Washing the Print.—The developed print must be passed from the developing dish into acidified water (water 60 ounces, hydrochloric acid 1 ounce), and remain face downwards for ten minutes. It should then be passed into another acid bath of a similar strength for the same time, and finally into a third bath, by which time all traces of iron should be removed. That this is effected can be told by the colourlessness of the last acid bath. The prints should be finally washed for a quarter of an hour in two or three changes of water. The Platinotype Company insist that in no case whatever should the prints be placed in plain water previous to the acidified water. They have, no doubt, valid reasons for this direction. Should a print be over-exposed, it may often be saved by using the developing solution at as low a temperature as 100° F.; whilst with under-exposed prints a temperature above 180° F. may be employed with advantage.

Sepia Paper.—The Platinotype Company issue paper which gives tones approaching sepia tones, and for it they issue special instructions, which are as follows :—

With few exceptions the method of carrying out the operations is the same as for the usual kind of Platinotype paper. The *additional points* to be attended to are as follow. When the picture is properly treated, the portions representing the shadows appear more deeply printed than would be the case with the usual kind of paper, because these parts more readily "solarise" (page 20)—indeed, in some cases, a large portion of the picture may be so affected. The detail in the delicate portions is not more visible than ordinarily.

Secondly, as the paper is more easily affected by faint rays of light, increased care must be taken when printing. The "sepia" paper does not remain in its best condition for so long a period as the "black" varieties.

To develop, add to each ounce of the solution of potassic oxalate (130 grs. in each ounce, or an old bath used for the usual kind of paper may be taken) one drachm of the Special Solution supplied for this purpose. Make the bath *thoroughly hot*, and proceed as described in the preceding section. It is important to use a high temperature—not less than 180° Fah.; indeed, the bath cannot be too hot.

A dirty, yellowish veil appearing on development all over the print, but more observable in the lighter portions, is due to one of the following causes :—1. Want of sufficient "Special Solution" in the developer; 2. Too much exposure of the developing solution to light; 3. Use of a dish in which the enamel is cracked so as to expose the iron.

Dishes enamelled *green inside* must not be used; neither should any but porcelain dishes be employed for containing the acid bath.

The bath after use should be put aside in a bottle apart from the ordinary developer, and, like the latter, must not be exposed to much light. This bath, when properly managed, has a tendency to improve with use.

The prints are cleared in an acid bath of 1 part hydrochloric acid (s. g. 1·16) to 45 parts water.

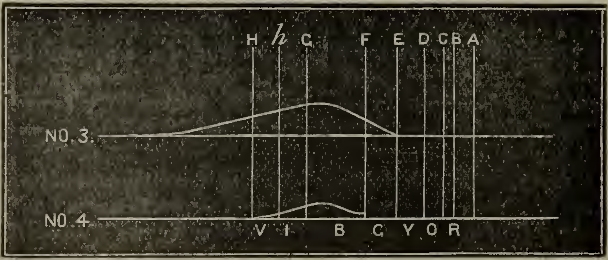
The subsequent and other operations are the same as for the usual kind of paper.

It is believed that the sepia tones result from a use of a salt of mercury with the platinum.

Sensitized paper will keep perfectly good, when properly stored, for several months, both before and after exposure.

To store the paper for subsequent use, the Platinotype Company supply tin cylinder boxes, round the lid of which slips an india-rubber band in order to exclude the external air with its moisture. Inside, at one end of this cylinder, is fitted a small circular box perforated, in which dry calcium chloride is placed to absorb any accidental moisture which may find its way into the box. A little cotton-wool, or a double thickness of muslin, prevents the access of the calcium chloride to the paper. This compound should be renewed from time to time, as it gets damp. The damp chloride may be dried by placing it in an evaporating dish over a bunsen Burner, and heating it strongly—in fact, till it fuses. It may then be broken up and re-used. It must be recollected that the main success of platinotype depends on maintaining the sensitive paper perfectly dry in all stages until the very moment of development. Hence the calcium

Fig. 26.



The top letters refer to Fraunhofer lines, the bottom letters are the initials of the colours. The height of the course denotes the relative sensitiveness to the different colours.

chloride tube should always be reverted to after a paper has been exposed and before development, and it should only be out of the dry atmosphere sufficiently long to allow it being placed on the negative.

It may be of interest to note the parts of the spectrum to which the ferric oxalate (and, indeed, most of the iron salts) are sensitive. No. 4 shows a short exposure to the spectrum; No. 3 shows a longer exposure.

CHAPTER XXXVII.

MOUNTING PRINTS.

When prints are taken from the drying line, they are found to be rolled up, and, it may be, in parts slightly cockled; in this state it is difficult to mount them. The method of *stroking* prints has been introduced to get rid of the defects. A flat piece of hard wood, about one foot long and one and a-half inch broad, and the thickness of a marquoise scale, has its edges carefully rounded off. The print is seized by one corner in one hand and unrolled; the face of the print is brought in contact with a piece of plate-glass. The "stroker," held by the other hand, is brought with its rounded edge on to the back of the print near the corner held by the first hand. Considerable pressure is brought upon the stroker, and the print is drawn through between it and the plate. The print is then seized by another corner, and similarly treated. By this means a gloss is put upon the print, and the creases and cockles are obliterated. The print is now ready for trimming.

It is well to have a square of glass with true edges cut to the size of the picture. The prints should be trimmed upon a sheet of plate glass, a sharp penknife being used to cut them. A rough test for ascertaining if the opposite side are equal is to bring them together and see if both corners coincide.

It may sometimes be found useful to cut out a print into an oval. The following method for tracing any ellipse may be employed:—On a thickish piece of clean paper draw a line A B, making it the *extreme* width of the oval required. Bisect it at O, and draw D O C at right angles to A B. Make O C equal to half the smallest diameter of the ellipse. With the centre C and the distance O B draw an arc of a circle, cutting A B in E and F.

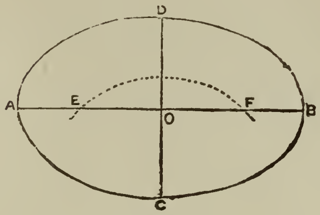


Fig. 27.

Place the paper on a flat board, and at E and F fix two drawing-pins. Take a piece of thread and knot it together in such a manner that half its length is equal to A F. Place the thread round the two pins at E and F, and stretch it out to tightness by the point of a lead pencil. Move the pencil guided by the cotton, taking care to keep it upright. The resulting figure will be an ellipse. Modifications of this figure may be made by making a second knot beyond the first knot, and placing the point of the pencil in the loop formed. When the figure has been traced in pencil on paper, it should be carefully cut out with a sharp penknife, and placed on the print which is to be trimmed into an oval. When so placed, a faint pencil line is run round on the print, and the cutting out proceeds either by scissors or penknife. Ovals, in sheet tin or brass of different sizes, are supplied by the dealers in photographic apparatus. The little instrument called the photographic trimmer is excessively handy

Fig. 28.

for cutting out the prints when these shapes have been procured. The cutting-wheel is brought against the edge of the shape, and, being pivotted, follows the curves mechanically.

There are a variety of mounting solutions in common use, the most favourite being starch. This is prepared in the ordinary way, and is laid on the back of the print by a hog's-bristle brush. Starch is dangerous to use, unless perfectly *pure* and *fresh.* It is apt to become acid, destroying the print in contact with it.

To prepare gelatine for mounting, take half a wine-glassful of gelatine, and cover it with cold water; when thoroughly swelled —which will be in about three-quarters of an hour—pour off any water that has not been absorbed, and fill up the wine-glass with boiling water. The gelatine will now be dissolved, and will remain fluid if the wine-glass be kept standing in warm water. This mounting medium is applied in the same way as the starch. Very thin glue is also occasionally employed, and answers well. In the market, at the present time, there are two or three made-up alcoholic mounting solutions, which answer admirably for small pictures, though when prints of 15 by 12 or over are to be mounted, it is rather difficult to give the back an even coating before the solution dries.

One great advantage of the solutions is that they do not cockle the mount, however thin it may be. Prints may be mounted on foolscap paper with the greatest ease, and they will be as flat as if mounted on the thickest cardboard. A solution suggested by Mr. G. Wharton Simpson is made as follows:—Take gelatine or fine shreds of glue, and swell them with the least possible quantity of water. Boil them with alcohol, keeping them in agitation with a stirring-rod the whole time. Eighty grains of gelatine will take about two ounces of alcohol to render it of a fit consistency for mounting. When cool the solution will become gelatinous. It can be used for mounting by letting it stand in a pot of warm water.

Before applying the mounting solution, the places where the corners of the print will come on the card should be marked with fine dots. The back of the print, having then been brushed over with the mounting solution, should be carefully placed on the mount, the corners coinciding with the dots. A piece of white blotting-paper should next be placed over the print, and the back of the print should be brought in close contact with the mount by rubbing the clenched hand over the blotting-paper. To obtain great evenness, a piece of white cream-laid paper may then be placed over the print, and the edge of an ivory rule or paper-knife be scraped briskly over it. This adds a brilliancy to the print, and prevents cockling in a great measure when starch or gelatine is used, all excess being squeezed out. An excellent plan to adopt to avoid cockling of the print, is to cover the backs with a thin layer of starch, and allow it to dry. Just before mounting, the starch is damped by damp blotting-paper, and it adheres to the mount.

The print is ready for rolling after the mounting solution is well dried, into the details of which it is not necessary to enter. The rolling machine which takes the form of the ordinary copper-plate press answers every purpose. Finally, the surface of the mounted print may be waxed. There are various formulæ for the encaustic, the simplest being:—

White wax	1 ounce
Spirits of turpentine...	1 ,,

the solution taking plainly by the aid of heat.

Mr. Valentine Blanchard uses white wax dissolved in benzole. This, he states, leaves a good coating of wax on the print, the benzole evaporating entirely.

M. Adam-Salomon's encaustic paste is made as follows:—

Pure virgin wax	500 grains
Gum elemi	10 ,,
Benzole	½ ounce
Essence of lavender	¾ ,,
Oil of spike	1 drachm

The waxing solution may be taken up by a tuft of cotton-wool, and spread roughly over the surface of the print. A clean pad of cotton-wool is then used to rub it well in, till the surface assumes a bright gloss, and is free from all appearance of markings. For increasing the depth of shadow and general beauty of a print, waxing is of the greatest utility.

There are other means of giving what is sometimes called an *inartistic* gloss to the print, the simplest with which we are acquainted being to squeeze a damp print in contact with the surface of a washed and wet plain collodionized glass plate, and to allow them to dry. The print is then stripped off, and the collodion film gives a brilliant surface to the finished print.

Recently, burnishers of a very excellent type have been introduced into the market. Burnishing gives extraordinary brilliancy to a print, and is easily executed with a proper machine.

Mounting Stereoscopic Prints.—Stereoscopic prints at one time were greatly the fashion, which it is a pity has gone out to a great extent, as views never look so realistic as when viewed in the stereoscope. For the production of a stereoscopic negative, it may be remarked, twin lenses of equal focal length are used in the camera, which is generally divided by a movable partition, the lenses being separated one from the other about 2½ inches. The print from such a negative must be cut in half, and the right-hand half mounted on the left-hand of a card, and the left-hand half on the right-hand. A little reflection will show that this is the position in which the eyes would naturally see them. If mounted as printed, we get a pseudoscopic impression on the eyes, which Wheatstone has fully explained.

CHAPTER XXXVIII.

THEORY OF PRINTING WITH DICHROMATES.

If gelatine be mixed with a solution of a dichromate of an alkali, and dried in the dark, it will be found that it is perfectly soluble in warm water. If, however, it be exposed to the action of light, it will be found to have become insoluble. On this rests the whole superstructure of carbon printing, Stannotype, Woodburytype, and some forms of photo-lithography and processes akin to them.

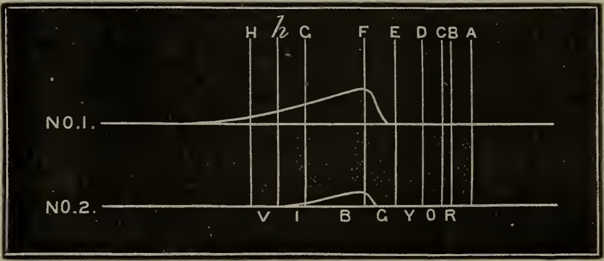
There is another method of producing insolubility in gelatine that does not prevent the absorption of water, viz., the addition to it of chrome alum, tannin, mercurous chloride, and various resins. Not only, however, is insolubility produced by light, but also an inability to swell through the absorption of water, which is not the case when the insolubility is produced by the addition of the above substances. These last, nevertheless, render the gelatine tough, and capable of withstanding a large amount of wear and tear.

Now if a layer of gelatine to which has been added potassium dichromate and (say) chrome alum be exposed to light under a negative, and subsequently immersed in cold water, a little reflection will show that it is *all* insoluble in water; but that where light has acted, it will refuse to swell by the absorption of water; and that where light has not acted, there it will absorb water. If a roller holding greasy ink be passed over such a surface, the ink will be repelled from all the swelled portions, since they contain water, whilst it will adhere only to those parts on which light has acted and which are free from water. If a piece of paper be pressed down on such an inked-in surface, it is manifest that we shall obtain a positive print on its removal. With half-tone subjects the ink will only take in exact proportion to the time for, and intensity with, which the light has acted on the gelatine surface, owing to the different parts containing more or less water. On this principle rest the processes of heliotype, papyrotype, and other surface printing processes. It is also manifest that if a gelatine film be treated as described in the carbon process, it will form a relief from which a mould may be taken, from which, again, a cast can be taken. This is the principle involved in stannotype and Woodburytype.

The chemistry of the process is rather involved in difficulties, on account of the organic changes that may take place in the gelatine. It will suffice to point out the main action that takes place, viz., that "gelatine, aided by light, reduces the chromic acid of the bichromate to a lower state of oxidation, and then enters into combination with a compound of chromic oxide produced by the mutual decomposition of the chromic acid and gelatine, being the formation of a leather-like substance"* insoluble in hot water. The addition of various substances to the gelatinous compound has been found to aid this decomposition.

There is one great advantage in the use of bichromate processes over silver chloride, in that they are sensitive to light

Fig. 29.



The top letters have reference to the Fraunhofer lines, the bottom letters are the initials of the colours. The relative sensitiveness is shown by the height of the curve above the base-line.

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* From a paper read before the Photographic Society, May 10th, 1870, by Mr. Swan.

comparatively low down in the spectrum. The maximum of sensitiveness is in the blue green, whilst that of the chloride is at the extreme limit of the violet. Hence with it in winter and in dull weather, printing takes place more rapidly than with the ordinary silver sensitized paper. No. 1 (fig. 29) shows the effect of a prolonged exposure of the spectrum; No. 2 shows a short exposure on same. The remarks on the actinometer used by the Autotype Company (see page 249) show the wonderful difference in the quality of light between summer and winter. Moreover, it has been found by the writer that when pigment is introduced into the gelatine it has little or no action on the rapidity of printing. The curves in fig. 29 should be compared with those at page 226.

CHAPTER XXXIX.

THE CARBON PROCESS.

The Carbon Tissue, as it is termed, is tiresome to prepare on a small scale; hence it is better to procure it direct from some firm. It can be supplied ready-sensitized, and be transmitted by post.

It may happen that the photographer is out of reach of ordinary sources of supply, in which case he may desire to prepare the tissue for himself. The following proportions for the gelatine mixture are taken from Liesegang's "Manual of Carbon Printing"*:—

Water	1	ounce
Gelatine...	120 to 150	grains
Soap	15	,,
Sugar	21	,,
Dry colouring matter	4 to 8	,,

The gelatine, sugar, and soap should be put into the water and allowed to stand for one hour, and then the colour is carefully ground up and added gradually, the gelatine having been first dissolved by the aid of heat. The mixture is then well stirred up, and finally filtered through muslin (see "Heliotype Process").

The quality of the gelatine is an important matter, and before taking into use it should be roughly tested by soaking 50 grains

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* "Manual of Carbon Printing," by Dr. Liesegang, translated by R. Marston (Sampson Low, Marston, and Co.)

of it in 1 ounce of water for a few hours. The excess of water when drained off should be tested by blue litmus paper for acidity, and for sulphates by the addition of barium chloride. If there be no acidity nor sulphate present, the same amount of water as was drained from it should be added, and the beaker containing it placed in warm water of about 90°. This should dissolve the gelatine, and when cooled it should set and be nearly transparent. If the set gelatine liquefies at a temperature of not less than 80°, it may be used. The best basis of the colouring matter is Indian ink, which can be softened by soaking in rain or distilled water, and then be rubbed down and filtered from the larger particles. The black colour thus obtained can be modified by the addition of alizarine, Vandyke brown, &c.; but there are some colouring matters which render the gelatine insoluble, and are therefore to be avoided.

Manufacturers coat long bands of paper by passing it over the mixture. Since this work is not intended for instruction to those who are commercially engaged in the preparation of tissue, but only for those who are learning photography, we have omitted the description of this method. The following method will be found suitable for preparing a small stock of tissue.

A glass plate is cleaned with nitric acid, next with potash, and finally, whilst still wet with distilled water, rubbed with oxgall. After carefully levelling (see page 138), sufficient gelatine (about 2½ ounces for a 12 by 10 sheet of paper) is poured on to the plate as in the Heliotype Process. After setting, a sheet of paper slightly damped is laid on the gelatine surface in such a way as to avoid air-bubbles. When the gelatine is dry it adheres to the paper, which is raised, and carries the gelatine with it, the separation of the latter from the glass plate being helped by means of a penknife.

Sensitizing the Tissue.—When unsensitized, it is necessary to float it on a solution of potassium dichromate and water—

Pure potassium dichromate	1 ounce
Water	20 ounces

The potassium dichromate should be nearly neutral, and contain no free acid. Should it contain acid, the tissue is liable to become insoluble. Free acid* may be neutralized by the addi-

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* Potassium dichromate always shows a slightly acid reaction to test-paper.

tion of potash in solution till no extraordinary acid reaction is evident to blue litmus paper. A dish somewhat larger than the sheets of tissue (as the gelatinized paper is called) to be floated is used for floating. The solution should be at least a quarter of an inch in depth in the dish. The piece of pigmented paper is taken, and a quarter of an inch folded back at one end at right angles, and rolled up to a diameter of about two or three inches, gelatine surface outside. The turned-up end remains on the outside of the roll. The angle of the folded end is now dropped upon the solution, and the coil of paper is allowed to unfold itself, driving out all bubbles behind as its surface comes in contact with the solution.

The floating should last from two minutes in warm weather to three in cold.* The turned-up end should then be pinned by a couple of pins on a thin lath, and the sheet of tissue slowly withdrawn from the bath, and hung up to dry.

Drying the Tissue.—The drying of the tissue should take place in a room perfectly free from vapours, such as sulphuretted hydrogen, or those produced by the combustion of gas. If possible, a current of warm, dry air should be created through the drying room ; in summer a large candle, or, better still, a gas jet placed in a chimney, will create sufficient draught, if the paper be dried near the fireplace. The quicker the paper dries, the better it will work, though the less sensitive it is to light.

Exposure of the Print.—When quite dry, the paper is exposed under the negative in the ordinary manner, a "safe edge," as it is technically termed, being placed round it. The safe edge consists of a mask of brown or other non-actinic paper, externally larger than the negative, and internally slightly smaller, the negative being, as it were, framed by it. The pigmented paper must be slightly larger—say a quarter of an inch each way—than the size of the print required. If the paper be examined during exposure, no change will be found in its appearance, owing to the colour of the pigments used ; consequently it is necessary to use an actinometer to time the exposure.

The original Autotype actinometer consists of a slip of albu-

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* Should the temperature of the solution exceed 80 F., it must be reduced by adding a little pounded ice.

menized paper* rendered sensitive by a standard silver solution. This becomes tinted or coloured by exposure to light. The tint thus produced is compared to a standard one, *painted* on a strip of paper or tin. When about to be used, a small portion of the strip of paper is exposed to the light simultaneously with the print. When the paper has attained the colour of the painted standard, it is said to have had one tint. A fresh piece of paper is then exposed for another tint, and so on.

There is another very simple way of telling the amount of exposure, and that is by the Woodbury photometer. The outer sectors are tinted to different depths with permanent tints. Below the inner circle a piece of sensitized paper is passed, it being coiled on a small roller within the instrument. This sensitized paper is exposed till it assumes, when viewed through yellow glass, the tint which is necessary to give to the print, and the tint taken compared with the sectors. The exposure can be timed by a watch, calculating the number of minutes that would be required from the time taken to give a certain tint.

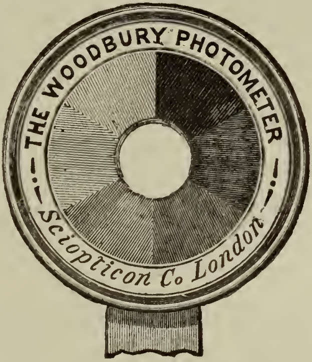

Fig. 30.

For a negative of ordinary density two tints of the Autotype actinometer will generally be found sufficient in the summer, and probably five in the winter (see page 229); but experience must decide the time required for different negatives.

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* Other forms of actinometer are employed, which depend more on the principle of that employed for heliotype.

The writer believes it would be an improvement to use bromized paper for the actinometer, instead of chloride, since the maximum sensitiveness to the spectrum of the bromide is nearly coincident with that of the bichromate (see pages 5 and 226). There would not be then that variation in summer and winter which has has been noticed above.

Continuating Action.—Some years ago it came to the writer's notice that the length of exposure to light necessary to produce a print by the autotype carbon process might be diminished by three-quarters, or even seven-eighths, by withdrawing the print from beneath the negative, and leaving it in the dark. The printing action once started continued gradually, and on development, after a lapse of several hours, the picture was found to be fully printed. In winter this curious continuating action was of special value, as it enabled from four to eight times the number of prints to be produced from a negative by giving only a quarter to an eighth of the right exposure, and then keeping them in a dark-room. The writer also experimented with certain non-actinic lights, and found that the same action was maintained, but with greater rapidity. Hence hanging a partially-exposed print up in a yellow-lighted room was better than leaving it in the dark. When one-quarter of the exposure was given, a print hung up in the dark was found to be properly printed in twelve hours; whilst if only one-eighth, it required sixteen hours. Mr. Foxlee subsequently showed that this action only took place in a moist atmosphere.

Development.—The development of the tissue should be conducted in a room in which the light is weak or non-actinic. Close at hand, on a table, should be a dish containing water to a depth of an inch or more. To the bottom of this is sunk a finely-mulled flat zinc plate, at least one inch larger each way than the negative; the paper is now drawn, face downwards, under the water, till it nearly rests upon the zinc plate. It will be noticed that the paper at first tends to coil downwards, but gradually unrols till it is perfectly flat, and if left longer that it would coil upwards. At the moment it has become flat, the zinc plate is seized by the hands, and raised horizontally out from the dish, the tissue resting upon it. It is then placed on a small low stool standing in another dish; one end of the plate is pressed on the zinc plate with one hand, and with the other remaining portions are brought into contact with the "squeegee."* The first portion of the tissue is then brought into contact with the zinc in the same manner.

The zinc plates used are termed the "temporary supports" of the tissue. They are mulled in the ordinary manner with a muller and fine sand; the finer the grain given, the finer in detail will be the resulting pictures. Care should be taken that no scratches are on them, as every scratch is reproduced in the finished print. It was found by the late Mr. J. R. Johnson, who introduced this method of transferring the prints, that it was necessary to coat the plates with a fatty and resinous substance, of sufficient tenacity to keep the prints on them during development, but which should have less adherence to them than the film of gelatine has to the paper with which it is backed or mounted.

The following is the composition of the fatty body:—

Beeswax	3 drachms
Yellow resin†	3 ,,
Oil of turpentine	1 pint

These proportions are not absolute, as the composition of the beeswax varies. The resin must be added to the beeswax to such an amount that the gelatine film, even when dried in a hot room, will remain on the plate without cracking or peeling, but, at the same time, will leave the plate readily—when the applied transfer paper has become dried—without the application of any force.

With a piece of fine flannel or cotton-wool, a small quantity of the above fatty body should be rubbed on to the plate. With another piece the excess of grease must be polished off, leaving but a minute layer of the compound on the surface. The zinc plate is then ready for the transference to it of the tissue.

The zinc plates are cleaned, after being used, by rubbing with flannel in boiling water. If this be not sufficient, a little turpen-

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* The squeegee consists of a flat piece of wood about two inches wide and three-sixteenths thick, into one edge of which is let a strip of india-rubber about half an inch wide, and projecting half that distance; the length of both the lath and india-rubber vary according to the size of the zinc plate. It is used by pressing the india-rubber edge against the paper, and passing it horizontally over the surface.

† The resin causes the adherence of the film to the plate, whilst the bees-wax diminishes that adherence to the limits above stated.

tine or ammonia will cleanse them thoroughly, and render them fit for a fresh application of the fatty compound.

For some purposes it may be deemed advisable to give the prints a more highly-polished appearance than that furnished by the use of a grained zinc plate. A glass plate prepared as follows answers the purpose :—

Beeswax in shreds	60 grains
Methylated ether	20 ounces

After resting twenty-four hours the solution is decanted. To each part of the clear fluid are then added five parts of benzoline. The plate is coated as with collodion, and dried. A coating of collodion is next given, and the surface thus prepared is used as a temporary support for the tissue.

Development is best effected by a trough or tin basin containing water, whose temperature can be maintained at 100° F. by aid of a gas jet or a spirit lamp. After the pigmented paper has been pressed into contact by the squeegee with the zinc plate, it should be laid aside for a couple of minutes, to allow the gelatine to swell. By the swelling of the gelatine a partial vacuum is created between it and the zinc plate, and the pressure of the air outside prevents it from peeling or stripping off. The zinc plate, with the adhering paper, is next placed horizontally in the trough for a minute, when it will be found that the paper can be peeled off, leaving the gelatine pigment on the zinc plate. The plate is now moved vertically in the water, or the water dashed over it with the hand; and gradually those parts of the gelatine which have been unacted upon by light will dissolve away, leaving the picture developed, with its half-tones and deep shadows in perfect gradation. When the water flows from off the plate quite free from colouring matter, it should be withdrawn, and then placed for a few seconds in alum and water (a dessert spoonful to a couple of gallons will suffice). This renders the remaining gelatine less soluble. Should a picture be only slightly under-exposed, plunging the plate into the alum and water at the stage required will stop development and give a passable print. If a picture be slightly over-exposed, water heated to 130° will often reduce its depth sufficiently. The plate, with the picture on it, should, lastly, be well washed under the tap to rid it of any traces of alum, and then be set up in a rack to dry.

It may seem curious to some that the pigmented gelatine should have to be transferred from paper to zinc plates to be developed, or, in other words, that development takes place from the face not exposed to light. A little thought will clear up the mystery. The light acts upon the pigment according to its intensity and to the *time* of exposure. A ray of light can only penetrate to do work to depth varying with its intensity (the variation is not a simple proportion, but much more complicated), and the amount of "work" done by it is in a ratio to the time of exposure.

The light passing through a negative at different parts varies in intensity. Thus it is evident that the insoluble part is at the surface, whilst the soluble is nearest the paper. Now, supposing it were attempted to develop the picture on the paper itself, it would be found that *nearly* all the *surface* of the pigment had become insoluble, and that consequently this leather-like substance would prevent the dissolution of the underneath portions which were still soluble.

The best exposure for the paper is evidently when the light has penetrated in the deepest shadows just to the surface of the paper, whilst the densest parts of the negative have not allowed the passage of *any light*. It will be seen from this that a negative should possess similarly good qualities as if it is to be used for silver printing.

The print on the zinc plate will be found to be reversed. This is as it should be, as in the re-transfer it will be found to be in its proper position. The transfer paper is coated with a preparation of insoluble gelatine. Fifty grains of gelatine are dissolved in one ounce of water, and three-quarters drachm of a saturated solution of chrome alum are added to it immediately before use. A sheet of paper is coated in exactly the same way as that described for making tissue. The re-transfer on to paper is effected in a similar manner to the transfer of the pigmented paper to the zinc. The paper is plunged into water of a temperature of about 170°, where it remains till it becomes slimy to the touch. The plate bearing the dried picture is dipped into cold water, and carries as much as possible away with it, and is placed in a horizontal position on to the stool already mentioned. The transfer paper is then placed, prepared side downwards, upon the cushion of water, and is "squeegeed" into close contact with the picture as before. It is then allowed to dry spontaneously (in the sun, if possible), after which it will be found to leave the plate readily, bearing with it the picture on its surface. If dried by the sun it will coil off the plate of its own accord. If the paper be too hastily dried by the fire it will buckle and become cockled, and can only be flattened with difficulty.

If a matt surface be required, the print may be finished by rubbing with cotton-wool holding a little turpentine. A brilliant surface can be given by using an encaustic paste as for silver prints :—

White wax	1 ounce
Benzole	1 ,,

dissolved by the aid of heat;

Or—

White wax	1 ounce
Oil of turpentine	1 ,,

dissolved also by the aid of heat.

For printing portraits a glass plate may be used in lieu of the zinc. As before stated, the surface should be rubbed over with waxing compound. Great care is requisite that the resulting surface is free from lines, as it should be remembered that every line on the surface of the plate will be exactly reproduced in the print. The glass may also be coated with a film of plain collodion (which should be *perfectly* transparent when dry), and, after varnishing round the edges of the film, may be used for the transfer. When re-transferred on to paper the collodion is detached, and the surface of the print is brilliantly glazed. It is advisable sometimes to rub over the plate, before applying the collodion, a little white wax dissolved in ether. This facilitates the film leaving it.

Flexible Support.—Mr. Sawyer, of the Autotype Company, has introduced a flexible temporary support as a substitute for the zinc plate. It is made with a preparation of gelatine, which with certain substances added to it cause it to be insoluble and impermeable. The advantage claimed for it is, that it expands with the tissue, eliminating the chance of a certain kind of blurring which has often been noticeable in gelatine prints. The results obtained by its employment demonstrate the correctness of the claim. Another point in its favour is, that the surface is less granular than with zinc, and the print is therefore more delicate.

The following is a description of the manufacture of the flexible support, taken from a paper read before the Photographic Society of Great Britain :—

"A solution of gelatine is made of variable strength, according to the quality of the surface desired in the finished print. For a print to have a dead or matt surface, I employ about a 5 per cent. solution; for a more highly-glazed surface, about 7½ per cent.; and for a surface equal to highly-glazed albumenized paper, a 10 per cent. solution. Paper wound on a reel, so as to be in a long length, is coated upon a carbon tissue-making machine with this solution, and, when dry, is cut into strips, and subjected to many tons' pressure in a hydraulic press. The solution of lac is made by dissolving one pound of button or bleached lac in five quarts of water in which have been dissolved four ounces of borax and one ounce of soda. This is put in what is called a digester, and heated until the lac is dissolved. The solution is then filtered, and, when cold, is ready for use. The gelatinized paper is floated on this solution in a shallow bath or tray, hung up to dry, and then finally rolled between metal plates in a rolling press. Each sheet is rubbed over with a little of a solution made by dissolving resin in turpentine, and adding thereto to a few grains of wax."

Single Transfer Prints.—There is another method of producing carbon prints without transferring them to zinc, viz., by transferring them direct to the paper on which they should finally rest. In order to employ this method, it is necessary to obtain a reversed negative. The transfer paper, prepared somewhat similarly to the re-transfer paper used in the autotype process, is soaked in very hot water, and, after the carbon tissue has been passed through cold water, the two surfaces are brought together by the squeegee or by pressure. The two papers are then immersed in warm water of about 100°, and the backing to the pigmented paper stripped off. The development of the positive takes place as usual, and the paper bearing the print is hung up to dry, when it is ready for mounting and finishing. Single transfer paper may be prepared by soaking white sized paper in water varnish (see "Heliotype Process").

Single transfer gives more delicate results than the double, no grain being present to mar the half-tones. The drawback to the process is the necessity of having a reversed negative.

Warnerke's Process.—A remarkable method of producing pictures in pigmented gelatine should be noted. Mr. L. Warnerke found that with a gelatine plate, if the image were developed by the alkaline developer, those parts of the gelatine in which a reduction of metallic silver took place were rendered insoluble. He prepared films of gelatino-bromide emulsion on paper, and made positives in the usual manner. He then transferred to glass the film bearing the image before or after fixing, and then stripped off the paper backing. The surface of the film which was originally exposed to the action of the developer now lay next the glass, and the most soluble portions were exposed. The application of hot water removed all the gelatine except that where the developer had reduced the silver, and an image in relief was formed in the same manner as in the carbon process. By mixing pigments with his gelatine emulsion, Warnerke was able to produce permanent prints by camera exposures. This process he has patented, and it is to be hoped that we shall hear more of it shortly on account of its remarkable simplicity.

CHAPTER XL.

THE POWDER PROCESS.

Under the head of printing processes comes what is usually known as the powder process. On the Continent it has been used with very good effect for the production of prints on paper, though in England its more familiar application is the production of negatives for transparencies on glass. The *rationale* of the process is as follows:—

When a tacky body of an organic nature is brought in contact with potassium dichromate, and is allowed to dry as far as possible, and then exposed to light, it will be found that, owing to the oxidation of that body by the chromic acid, the tackiness will disappear in exact proportion to the intensity of the light acting on it. If a glass plate be coated with such a preparation, and be placed beneath a half-tone negative, the densities of the different portions of the negative will be represented by different stages of tackiness. A fine powder sprinkled over the exposed surface will adhere to the tacky portions in the ratio of the tackiness. Hence a picture will be built up which will be a counterpart of the negative, only reversed. From this it will be manifest that in order to obtain a positive picture a reversed positive must be employed; though a line engraving, for instance, may be directly copied by this method by allowing the back of the engraving to be in contact with the sensitive surface.

The following are the formulæ that have proved, in our hands, most successful:—

(*Obernetter's Formula.*)

Dextrine	1 drachm
White sugar...	$1\frac{1}{4}$,,
Ammonium dichromate	$\frac{1}{2}$,,
Glycerine	2 to 8 drops
Water	3 ounces

Or,—

(*Woodbury's Formula.*)

Gum-arabic	1 drachm
Glucose	$\frac{3}{4}$,,
Glycerine	10 drops
Potassium dichromate	30 grains
Water	2 ounces

Whichever formula is employed, the solution should be filtered whilst warm, and be kept in a glass-stoppered* bottle.

A glass plate is next cleaned, and, if thought desirable, coated with a thin film of porous collodion, allowed to set, and then washed under a stream of water till all greasiness due to the solvents has disappeared. When drained, sufficient of No. 1 or 2 is taken in a clean glass measure, and allowed to flow over the surface two or three times. After pouring off the excess of fluid the plate is dried at about 150° F., or gently over a Bunsen burner or Argand lamp, &c. Whilst still warm, and before the surface has had time to re-absorb moisture, the plate is placed in contact with the transparency or negative from which it is desired to obtain a copy reversed as regards left and right, and placed in sunlight for two or three minutes, or in bright diffused light for ten to fifteen minutes. On removal from the printing-frame a faint image will be apparent, should the printing have proceeded far enough. The film is now exposed to the air in order that it may imbibe moisture, and plumbago† is applied with a large flat brush. The lights or shades are now represented by the graphite according as a negative or transparency has been superimposed.

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[*] A cork should not be used, as any extraneous organic matter is fatal to good results.

[†] The plumbago should be of the finest description; that used by electrotypers answers better than any other we have tried.

When the image has been fully developed, the superfluous powder is gently dusted away, and the film coated with tough collodion (that used for transferring films answering well). When well set, the plate is placed in water to allow the solubl gum and dichromate to dissolve out; and, if desired, the film may be detached from it by cutting round the edge with a sharp knife, and treating it as shown in the chapter on "Enamels." The film thus detached may be made to adhere to any support required—such as paper or glass—by giving it a thin preliminary coating of gelatine.

The application of this process to paper can be now understood. In practice is is found advantageous to give it a good smooth sizing of gelatine previous to coating with the above. Ordinary albumenized paper, the albumen of which has been coagulated by heat and afterwards washed, may be substituted.

CHAPTER XLI.

WOODBURYTYPE AND STANNOTYPE PROCESSES.

Woodburytype Process.—Mr. Walter Woodbury has successfully worked out two processes of producing prints which may be classed under the head of photo-mechanical processes. The first it would be difficult for amateurs to undertake, owing to the apparatus that is necessary. The following, however, is an outline of it. A film of sensitive gelatine is placed beneath a negative and exposed to light. The gelatine film, when fully exposed, is developed by washing away the soluble portion, and the picture is now in relief, the highest lights being represented by the lowest relief. When dried, the gelatine print is placed on a soft metal plate, and driven into it by means of immense pressure, an hydraulic press being employed for the purpose.

An impression from the gelatine metal can also be taken by means of fusible alloy, as shown recently by Mr. Bolas. In this case, heat is applied to the top surface of the alloy, whilst cooling, in order that any contraction may take place away from the gelatine surface, by allowing the alloy in contact with it to cool first.

The metal sheet now becomes a mould, and is placed in a position on a metal table which forms part of the Woodburytype process. Beneath the lid is a perfectly flat glass plate, which is so adjusted mechanically, that it makes actual contact with the metal mould. A solution of gelatine in a hot condition, containing pigments or dyes, is run into this last; a piece of homogenous and specially prepared paper is placed over it, and the lid shut down. The pressure causes all the superfluous gelatine to exude, whilst that in the mould adheres to the paper.

When set, this is lifted off, and a picture appears in relief, the lights and shades being formed by varying thicknesses of gelatine. An immersion in a weak solution of alum causes the gelatine to become insoluble, and the picture, when dried, is ready for trimming and mounting. It will be noticed that, like the Autotype process, the print is dependent for its shade on the transparency of the pigment. Hence, the more transparent the colour employed, the better the half-tones are likely to be.

The pictures produced by this process are now well-known to most people, illustrations of cheap periodicals being frequently executed by it. They are beautiful and delicate, and, as far as at present known, permanent. The greatest drawback to Woodburytype is the difficulty experienced in obtaining pure white for any large surface, as in the skies of landscapes.

Stannotype Process.—The Stannotype process, which is also the invention of Mr. Woodbury, has received much attention in various ways lately, and is becoming daily more generally used. Briefly it may be said to be a simplified method of producing prints by the Woodburytype method, with this special distinction, that the "moulds" are produced by different methods, the Woodburytype "mould" being produced by a gelatine relief, being cut in soft metal by heavy pressure; whilst the Stannotype "mould" is prepared by a gelatine *intaglio* being procured, and having tinfoil placed in absolute contact with it to form a printing surface.

The first thing to be done in producing a Stannotype printing "mould" is to obtain a transparency from the negative to be reproduced; and as the success of the subsequent operations depend much upon the quality of it, it is essentially necessary that it should be an excellent one. Experience has shown that the simplest and most suitable transparencies are produced from carbon tissue, which give little or no relief. The carbon tissue transparency has two advantages over other methods, as from a thin or weak negative a good rich transparency can be obtained by intensifying it in a solution of permanganate of potash until the necessary gradation is obtained; and, secondly, retouching can be done on it, and clouds, figures, &c., introduced on it. A transparency should possess sufficent density to allow of the long exposure to light that is necessary to produce the required depth of relief in the "mould," and whilst possessing good gradation in the half-tones, perfectly clear glass should represent the high lights. Carbon tissue is sensitized by being immersed for three minutes in a four per cent. solution of bichromate of potash, and is then dried in a warm dark-room; when dry, the tissue is exposed in contact with a negative that has had a mask placed on it, one-eighth of an inch larger than the picture that is required (to form a "safe-edge," see page 248). The exposure is then made, and guided by an actinometer according to the density or otherwise of the transparency. When the exposure is complete, the tissue is placed in a dish of water for a short time, and is then laid on a sheet of glass that has been collodionized (plain collodion). A sheet of india-rubber is laid on it, and the print is squeegeed in contact with the glass. After a lapse of a few minutes it is placed in a dish of water of a temperature of 90° F. In a few minutes the paper backing of the tissue can be stripped off, and the development commenced; when sufficiently developed, the transparency is finally washed in cold water, and allowed to dry. If necessary, it is intensified by immersion in a solution of permanganate of potash (the strength of which is not very material), and again washed in cold water, after which it is permitted to dry.

A suitable transparency having been obtained, the second step is to prepare the "mould," or the gelatine *intaglio*, which, when completed and covered with tin-foil, forms the printing surface. For this purpose a specially prepared,* lightly-coloured tissue is used. It is very much thicker than ordinary carbon tissue, so that it may afford the necessary degree of relief. This tissue is sensitized in a six per cent. solution of bichromate of potash, in which it remains for five or six minutes. It is next placed in a drying-box specially fitted with trays which contain calcium chloride, so that the drying may be done expeditiously, and prevent the tissue from becoming insoluble. When dry the tissue is placed in contact with the transparency, which has had a "safe edge" of a quarter-of-an-inch in width placed round the transparent part obtained by the previously-used "safe edge." The tissue is exposed with the transparency

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* Contains a very small quantity of colouring matter.

from 7 to 12 tints (see page 249), and is judged by the same photometer used for timing the transparencies.* On the exposure being completed, the tissue is developed by being squeegeed to patent plate glass that has had a substratum of gelatine, alcohol, and chrome alum (see page 91), and then collodionized with plain collodion. The tissue and the plate, before the collodion is dry, are immersed in cold water until the tissue shows signs of curling up. They are then lifted out of the cold water, and the tissue squeegeed to the plate; a sheet of blotting-paper is then placed over them, and they are kept under a heavy weight or pressure for a quarter of an hour. They are now placed in a dish of water heated to 110° F., and watched till the paper backing is stripped from off the tissue. The mould is now at intervals examined till the development is completed, which takes several hours, after which it has very hot water poured over it, and is finally rinsed in cold. To dry it, it is placed in alcohol in a flat dish, where it is left for several hours and is allowed to dry; the alcohol eliminates the moisture, and the drying is more even. Before the *intaglio* is coated with tin-foil, all defects are removed in a very simple way, by scraping with a strip of glass.

The "mould" is now to be covered with tin-foil, to effect which a very thin solution of india-rubber dissolved in benzole is flowed over it; when set, but not perfectly dry, a sheet of tin-foil that is free from holes, even the minutest pinholes, is flatted with a soft brush on a sheet of glass, and from thence is placed on the mould. To secure the foil taking in all the hollows, it is passed between two india-rubber rollers of a press, which is something like an ordinary clothes-wringing machine. The rollers can be closed or separated, to allow the "mould" with tin-foil passing easily between them. The pressure is just applied to the centre of the plate, and thence applied outwardly. The plate is then moved backwards and forwards between the rollers by turning the handle of the press, until the tin-foil is forced into all the depressions, and is in absolute contact with the gelatine surface.

The "mould" is now ready for printing from. A piece of stout card is soaked in water till it becomes soft, and is placed on the bed of the press; the mould is next laid on it.

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* That was used for timing the exposures of the transparency.

The three screws attached to the top of the press are loosened, which permits the top plate to rest on the "mould," and to find its own level. The press is then closed by pushing the handle forward on to the lip of the arch of the press; the middle screw under the arch of the press is now screwed tightly up, the top screw is next fastened, and lastly, the bottom screw is tightly screwed downwards. The top plate is now level, and the "mould" is ready for printing from. The press is opened, the "mould" is gently oiled with a mixed oil, which is carefully rubbed over the whole of the printing surface, a printing ink prepared with gelatine and such colours as indian-ink, carmine, &c., are poured on the centre of the mould. A piece of paper with a resinized surface is laid on the ink, the press is then closed, and clamped by the handle. The gelatine is allowed to set. The press is again opened, and the print taken from the "mould." This procedure is repeated for each print.

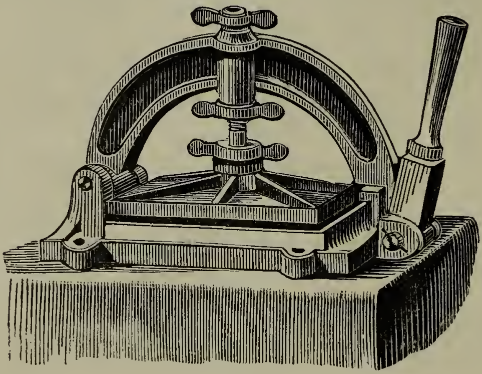

Fig. 31.

After the gelatine image is thoroughly set on the paper, the print is immersed for a short time in a saturated solution of alum, and finally rinsed in cold water. When dry, it is ready for trimming and mounting.

CHAPTER XLII.

THE HELIOTYPE PROCESS.

The Heliotype Process.—In the heliotype process a film of gelatine is prepared on a glass plate, from which it is stripped when dry, and printed in the ordinary manner under the negative. The proper preparation of the film is of the highest importance, and unless properly performed, the resulting prints will be imperfect.

The glass plate should be perfectly flat, and finely ground* on one side. To prepare it, the ground side is waxed with a waxing solution of white wax dissolved in ether. This is applied plentifully to the plate with a soft rag or cotton-wool, and rubbed well in. As much as possible is then removed with a little ether or spirits of wine, till the surface presents an even and almost polished appearance. When required for use, the waxed surface of the plate is levelled by means of a spirit level, little wedges of wood being a convenient means of effecting it (see page 138).

The following formula may be used in the preparation of the "skins" of gelatine for plates 22 by 16:—

No. 1.—Gelatine	... ...	1½ ounce
Glycerine	... ...	1 drachm
Water	... ...	12 ounces

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* The polished surface of the glass may be employed by coating it with plain collodion containing equal parts of ether and alcohol, and about seven grains of pyroxyline, which gives a horny film; or by a solution of india-rubber in benzole.

The gelatine which answers well, and is cheap, is Nelson's No. 3 Flake. It should be allowed to swell in the water, and, when thoroughly swollen, should be melted over boiling water, and then the glycerine added. The temperature of the gelatine should not rise above 115° F., and the solution should be stirred till a perfectly even fluid is produced.

The sensitizing solution is made as follows:—

	For Summer.	For Winter.
Potassium dichromate of potash	22 grains	30 to 40 grains
Chrome alum	15 ,,	15 to 7 ,,
Water	12 drachms	12 drachms

This quantity, after heating to 100° F., is added to the prepared gelatine solution immediately before use; in fact, it should be added in the vessel from which the plate is to be coated, and stirred well, to form a perfect mixture. A piece of muslin is tied over the top of the vessel, and the gelatine allowed to strain

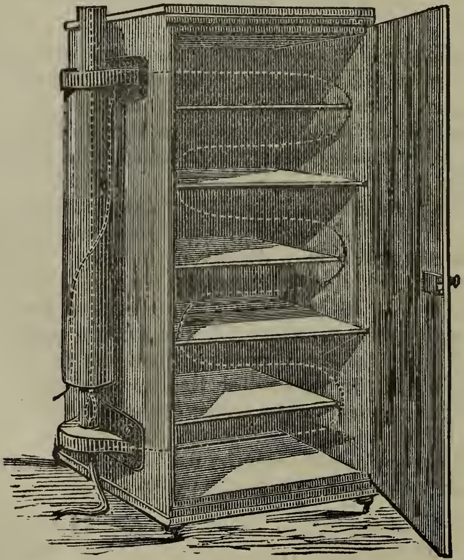

Fig. 32.

through it on to the levelled plate. The surface having been covered, and the gelatine allowed to set, the plate can be placed away from all dust in a drying room through which a current of air of about 75° is passing. The drying-room should be glazed with deep orange glass, and be kept nearly dark. Ventilation is a *sine qua non*. M. Leon Vidal recommends a drying-box the form of which is due to Mr. Rogers. The general appearance it presents is given in fig. 32.

The section below (fig. 33) of the box shows the general principles of the figure, but the exit pipe for the warmed air is at the top of the box instead of at the side. The drying-box may be of any dimensions. P is a one-inch piece of gas-piping standing on the box C, and through it a small pipe carrying a minute gas-nipple passes; it is soldered in air-tight at the bottom of C, and is connected by an india-rubber tube, 1, with the gas; Z is a three-inch stove pipe, soldered up at one end, and open at the other, through which P passes; a small leather washer, W, makes the zinc tube air-tight at the top; D is an outlet tube passing into the top of the box, over the opening of which may be stretched muslin in order to arrest the entrance of all dirt

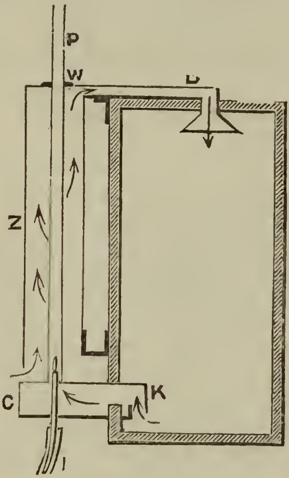

Fig. 33.

into the interior. At K is a "light-trap," to exclude all light which might be reflected from G, the gas jet; a current of warmed air thus perpetually circulates in the box B. The gas is lighted by raising the pipe P from off C, which is then replaced. The plate gradually dries after twenty-four to forty-eight hours. The film will keep sensitive on the plate for a week or more.

Another formula is appended, which has the advantage of giving an opaque white film :—

No. 2.—Gelatine	2 ounces
Glycerine	3 drachms
Water	9 ounces

This is prepared as before, but, just before use, and before adding the sensitizer, five ounces of skimmed milk (which has been warmed, to cause the cream to rise) are stirred up with the solution. The sensitizer is then added as before :—

	For Summer.	For Winter.
Potassium dichromate	22 grains	30 grains
Chrome alum ...	7½ ,,	5 ,,
Water	12 drachms	12 drachms

When dry, the skins are stripped from the glass plate, the edges being raised by a penknife. It is best to allow them to stay for half-an-hour in a place where the temperature and moisture are similar to that to which they will be subjected during exposure. This will prevent any danger to the negative in the printing-frame. The skin is next placed, with the surface which was not in contact with the plate uppermost, on a board on which has been nailed black velvet. Two small strips of the skin are cut from its edge, and placed one over the other in an ordinary printing-frame, with an opaque mask over them, in which is cut a lozenge-shaped hole. This is exposed to the light with the skin. When the image of the hole is seen well defined on the nethermost strip of gelatine, the skin is withdrawn, and its surface, which was in contact with the glass, placed in contact with a *reversed* negative in a printing-frame. (It is advisable that all the skin, excepting that under the negative, should be masked, to prevent the light acting on it). Any ordinary actinometer is now

3	4	5	6	7	8	9	10	11	12

brought into requisition. The simple one we have used is made of different thicknesses of yellow oiled silk. It is constructed as in the figure. Each number denotes the number of thicknesses of the silk; hence, when on a strip of sensitive gelatine 6 is seen, the light has penetrated through six thicknesses; when 7, through seven thicknesses, and so on. A half-tone negative of ordinary density requires the number 10 to be read on a piece of the sensitive gelatine placed beneath it; a clear line subject, not more than 6 or 7. Of course the actinometer is exposed in the same light as the skin.* When a negative is weak, it may only be half printed, and the continuating action (see page 250) allowed to act for twelve or twenty-four hours, when a more brilliant result will follow. In this case the preliminary sunning of the skin should be lessened, for obvious reasons.

Preparing the Transfer Plate.—A smooth metal plate of slightly larger dimensions than the skin (by preference pewter or nickelled steel) is coated with a solution of india-rubber in benzole,† of the consistency of thick collodion, and allowed to dry. The skin is then placed in water, with the prepared plate beneath, for two to three seconds, and both are withdrawn, leaving a layer of water between the sunned side of skin and the coated surface of the plate.

A large squeegee is next brought to bear, and the two surfaces brought into close contact, as in the double transfer carbon process (page 252). If any dust be between the two surfaces, there is great danger of blistering. When squeegeed down, the edges are brushed round with india-rubber solution, to prevent the water penetrating underneath, and, when nearly set, the plate is immersed in water for periods varying from ten minutes to one hour.‡ When all the dichromate is washed out, the surface of the skin is wiped dry, and is then ready for printing.§ Blisters having their origin in dust or bubbles in the film can generally

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* A small carte-de-visite pressure-frame is convenient for holding the actinometer.

† Ordinary rectified lamp benzine answers every purpose.

‡ For a skin prepared according to No. 2 formula, ten minutes are sufficient.

§ Should a collodionized or india-rubber surface have been used, care must be taken that all the collodion or india-rubber is detached before printing. These polished surfaces have great advantages, having no grain.

be forced out by applying the flat part of the hand, and squeezing them out to edge.

Printing from the Gelatine Picture.—The plate is now laid on the bed of a printing-press, and small strips of paper are pasted with india-rubber over the edges of the skin on to the plate. A piece of bibulous paper is placed on the skin, and a good hard pressure brought to bear; this squeezes out most of the superfluous water, and leaves the plate ready for inking. Best lithographic chalk ink* should have been prepared with green oil, and be of the consistency of soft wax. The gelatine or india-rubber roller should be coated with this ink by rolling on a stone slab or slate. When coated, the roller is applied, evenly and smoothly, to the plate. Those parts acted upon by light will take the ink, whilst all others will repel it. If the picture be a half-tone one, a thinner ink of any colour made up with oil or Russian tallow may be used on another roller. This roller will not rob the plate of the first, on account of the thinness of the second ink, but will give detail in the high-lights. Paper is now placed on skin, and, with a moderate pressure, a proof is pulled. Should white margins be apparent round the blackest shadows, or if the relief of the plate be too great, it is a sign that the surface requires "smashing down." This is done by placing bibulous or enamelled paper on the skin, and bringing down the platen of the press with a great pressure. This gradually diminishes the relief. More ink is applied, and proofs are pulled till satisfactory results are obtained. The surface of the skin between each proof pulled should be slightly damped with a sponge, and the excess of moisture got rid of† by the squeegee and blotting-paper. This keeps the whites clean as in lithography, and gives pluck to the resulting picture. If the whole of the picture be too deeply printed, a little dilute ammonia (one part to four parts of water) may be sponged over the surface till the over-printing is no longer visible. In order to keep clean margins to the prints, a mask is cut out of the shape required. The mask paper is prepared as follows:—Stout bank post is laid flat on a board, and boiled linseed oil is brushed over it; or similar paper may be coated with a wash of india-rubber dissolved in

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* *All inks* should be *very* finely mulled.

† This should be done as quickly as possible, as, if not, the film is apt to become unequally damped, and give an unequally-printed proof.

benzole. It is hung up by clips to dry, and is then ready for use. The mask, of course, is turned back between each inking-in of the picture.

Paper.—Any kind of paper may be used with "milk" skins. Enamelled paper answers best with the ordinary ones, and is prepared with baryta white and gelatine and chrome alum. Of ordinary paper, that answers best which is found most adhesive when the tip of the tongue is applied to its surface.

Varnishing Prints.—If thought necessary, the prints may be varnished, after pulling, by a water varnish. This is made by dissolving shellac in boiling water to which a little ammonia has been added. As the shellac dissolves, more is added, stirring the solution the whole time. From time to time more ammonia and shellac must be added, till the varnish, on drying, leaves a brilliant surface. The varnish is filtered, and applied to the print with a flat brush.

Preparing the Gelatine Rollers.—The rollers are made of a solution of gelatine to which glycerine and castor oil are added. They are moulded in a cylindrical mould, on perforated wooden rods, similar to the manner of preparing ordinary printing rollers. A roller for a first ink is coated with gold size and the fluff of blotting-paper; a second ink roller remains with the gelatine surface to take up the ink. India-rubber rollers can also be obtained, which answer well. The great secret of producing a good heliotype is to have first-rate rollers at command.

Failures.—The usual source of failure is in the skins, in washing, when not kept sufficiently free from dust, and in which air-bubbles are to be seen. In winter, blisters will appear from the above causes, as well as through too low a temperature of the wash water. The washing water should never be below 60°. If a skin be over-sunned, or be kept too long after sunning, a scum of ink will invariably be apparent on the high-lights. If a picture be over-printed under the negative, it may often be corrected by the judicious application of ammonia, as given before. If it be under-printed, thinner inks may be tried; but it is better to print a fresh skin than to waste time over experiment. Imperfections in the prints often arise from the imperfect use of the squeegee and blotting-paper, and from an uneven coating of the rollers with ink.

CHAPTER XLIII.

ORDINARY PHOTOTYPE PROCESSES.

All other kinds of photo-mechanical processes are, it is believed, those by which the gelatine film is printed from without removal from the glass plate. We give an outline of a process which has proved satisfactory in the hands of many.

Preliminary Coating with Albumen.—First of all, it is usual, though not absolutely necessary, to use a thick glass plate as the basis from which the print has to be produced, and this being so, it is necessary to secure adhesion of the gelatine to it by some means or another. A usual plan is to grind the surface a fine grain, and then to coat it with the following solution :—

Albumen	3 drachms
Water	2½ ,,
Ammonia	1½ ,,
Bichromate of potash	4 grains

The bichromate is reduced to powder in a mortar, and the ammonia and water added to it. The albumen, after beaten to a froth, is allowed to subside, and the measured quantity added to the above solution. This solution is poured over the ground surface of the thick glass plate, which should be about three-eighths of an inch in thickness, care being taken that no bubbles are formed. The excess is then drained away, and the plate is allowed to dry spontaneously. When dry, this film is exposed through the *back of the plate* to light for from ten to twenty minutes. This hardens the surface of the albumen next the glass, and renders it insoluble, whereas the outer surface remains partially soluble.

Husnik avoids using this preliminary preparation by using the following:—

Albumen...	8 parts
Commercial silicate of soda	5 ,,
Water	7 ,,

These are mixed together and allowed to settle, and the clear liquid is decanted off, or, if necessary, filtered. Great care should be taken that no particles of dust get on the plate when coated. The plate is covered as with collodion, and allowed to dry after all excess has been drained away. It is then ready to receive the sensitive preparation.

Sensitive Gelatine Preparation.—The gelatine solution is made as follows:—

1.—Gelatine (Nelson's No. 2 flake) ...	1 ounce
Water	8 ounces
2.—Potassium bichromate	160 grains
Water	4 ounces

The gelatine is allowed to swell, and then dissolved, and the bichromate solution added. The temperature should be kept up to about 100°, and the plates should be slightly warmed to receive this solution, It is difficult to say how much gelatine solution each plate should receive. The film should be very thin when dried, the thickness of a gelatine emulsion film being sufficient. For a 12 by 10 plate, about half an ounce of the solution should suffice. The reason of keeping the thickness of the film to a minimum is to prevent the relief, after printing and soaking in water, being too high, and at the same time, it is necessary that the film should be sufficiently thick to imbibe a sufficient quantity of moisture when damped for inking-in. The hardness of the film has something to do with the success of printing, as has also the "grain" of the gelatine after printing. A certain amount of very fine grain is necessary in order to obtain adhesion of the ink to the surface. The addition of ten grains to the ounce of tannin to the foregoing solution helps matters, but it must be added very cautiously, being dissolved in one ounce of water, and added with stirring. If the gelatine be too soft, quarter of an ounce of isinglass may be used with advantage. To secure grain, in some instances oxide of zinc has been added, and also plates are immersed after printing and washing in alcohol.

Printing the Image.—The image is printed as given in the heliotype process.

Colonel Waterhouse says:—"It is advisable to secure clean margins by shielding the borders of the negative by means of a mask cut out in yellow or brown paper, which should well overlap the edges of the printing plates. The mask is laid on the glass of the pressure-frame, then the negative in its proper position (should this be a transferred film, it is advisable to place a glass plate between it and the mask, in order to secure the most perfect contact); the sensitive plate is then rubbed over with a little powdered soapstone, to prevent its adhesion to the negative, and adjusted in its place over the negative, covered with a sheet of black velvet or brown paper, over which a thick glass plate is laid, and, if necessary, a few sheets of thick paper to give a good strong pressure, when the bars are shut down. The thick plate of glass has been found to give much sharper and more even contact than the usual backboard.

"The amount of exposure to light varies from about ten minutes in the sun for a clear line subject, to from twenty-five to fifty minutes for a subject in half-tones, according to the subject and intensity of the light; but, as it is impossible to judge of the progress of the printing by inspection, it is necessary to use an actinometer as a guide to the exposure (see page 249)."

Whatever preliminary coating has been given to the plates, a slight exposure through the back of the plate should be given to avoid too great a relief. This exposure will be far less than with the heliotype process, as the film of gelatine is much thinner.

It is as well to carry on the second exposure under a piece of ground glass; otherwise, if there should be any scratches on the back of the sensitive plate, or on the glass of the pressure-frame, they will show as white lines on the print; after this the plate is taken out of the frame; a little tallow is rubbed round the edges to prevent water getting underneath and stripping the film; it is then plunged in water and thoroughly washed until all traces of bichromate have been removed, and is ready for printing.

Printing the Picture in the Printing Press.—We cannot do better than give Colonel Waterhouse's description of inking-in a picture on a plate somewhat similarly prepared. He says :—"When the exposure to light is considered sufficient, the negative and mask are removed, and the back of the sensitive plate is then exposed to light for about five or ten minutes, to thoroughly harden the gelatine, and prevent it from swelling too much in the after process.

"The plates may be printed in the lithographic press, and then require to be fixed on a level stone with plaster of Paris. It has been found, however, more convenient, and in other respects better, to print them with vertical pressure in the ordinary Albion press; and in order to prevent their being broken, the bed of the press is fitted with two or three thicknesses of kamptulicon, besides a sheet of vulcanised india-rubber on which the plate rests. It is also desirable to place a sheet of white paper over the bedding, in order to enable the state of the plate, when it is being inked up, to be better seen.

"The plate, having been well soaked in water, is laid on the press, and, after having been wiped to remove the excess of moisture, is inked in, if a line subject, with an ordinary lithographic roller charged with an ink composed of lithographic chalk ink thinned with a little olive oil, followed by a rolling with a smooth roller to clean away the superfluous ink; a mask of the required size is laid on the plate, over this comes the printing paper covered with a piece of soft felt to drive the paper well into the hollows of the plate, the tympan is lowered, and the impression pulled in the ordinary way. The plate is then damped, and the work goes on in the same manner without difficulty.

"For printing in half-tones, however, the process is somewhat different.

"The plate is first inked-in by means of a small leather hand-roller charged with stiff ink (rendered stiffer, if necessary, by the addition of a little Canada balsam), which takes only on the deeper shadows; the half-tones are then brought out by rolling in with a smooth lithographic roller charged with a lighter and softer ink. Rollers composed of glue, treacle, soap, and catechu have been found useful in certain cases for inking-in the plates; but, on the whole, the lithographic rollers are preferred. The impressions are best when printed on enamelled paper, but a smooth glazed printing paper also seems to answer well.

"Before putting away the plates after printing, they are washed with turpentine, followed by a very weak solution of caustic potash, to remove all traces of the greasy ink; they may also be treated after this with a mixture of gum and glycerine with advantage.

"*Corrections.*—A point which seems likely to greatly interfere with the extended use of the process was the difficulty of making corrections on the plates. I am glad to say that some experiments lately tried have shown that it is practicable both to insert and to take out or clear up details on the gelatine films.

"The insertion of details may be accomplished by two or three methods. The first is by writing in the required additions on the dry plate with a pen or fine brush, using an ink composed of bichromate of potash, used alone, or slightly coloured with Indian-ink or indigo. After the additions are completed, the plate is exposed to the light for ten minutes or a quarter of an hour, till the bichromate is thoroughly reduced, and may then be washed and printed as usual. In some cases the same object may conveniently be accomplished by brushing over the part with solution of bichromate of potash, allowing it to dry, and then printing in the required details from another negative.

"Experiments have shown that details may be taken out by the aid of a solution of caustic potash or cyanide of potassium; and should a plate print dirty, it may be cleaned up and greatly improved by the use of a weaker solution of the latter substance.

"It often happens that the plates show too much relief in the lights, and that the ink will not take readily on the shadows or lines represented by the deepest hollows. This relief may be reduced by brushing the plate over with dilute nitric acid, one-sixth or weaker. The plate is then washed, and, on inking-in, the ink will take readily in the lines or hollows."

CHAPTER XLIV.

PHOTO-LITHOGRAPHY AND ZINCOGRAPHY.

PHOTO-LITHOGRAPHY is an important branch of photography where the rapid copying and multiplying of large subjects is in question, and requires much care and dexterity to carry out. It is rarely to be found that the process is worked satisfactorily by a beginner, but that constant practice will render it easy.

The part that is played by photography in photo-lithography is the obtaining from a negative a print* in greasy ink which may be laid down upon the ordinary lithographic stone or a zinc plate.

Southampton Plan for Preparing Transfers.—Make the following mixture:—

Potassium dichromate...	2	ounces
Nelson's fine-cut gelatine	3	,,
Water	50	,,

The dichromate is dissolved in 10 ounces of water, and added to the 40 in which the gelatine, after proper soaking,† has been previously dissolved by the aid of heat. Good bank-post paper (very grainless) of a medium thickness is selected, and, if this cannot be obtained, ordinary thin paper may be substituted, and cut into sheets a little bigger than the negative to be printed from. The solution is strained and poured into a dish through flannel.

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* Called a transfer.

† The gelatine should soak in water just sufficient to cover it, and then the remainder of the water should be added in a boiling state.

The temperature is kept up by placing the dish upon a tin box containing hot water, and kept warm by a spirit lamp placed beneath it.

The paper is floated for about three minutes, and hung up by two corners to dry in a room which is non-actinically lighted, and is perfectly free from dust. When dry, the paper must be floated again as before. The sheets should be hung up from the opposite corners to those by which they were hung after the first flotation. Should it be considered desirable to coat the paper with gelatine first, and then sensitize, the dichromate may be omitted from the foregoing formula. The sensitizing is then effected by floating the prepared paper for one minute on a cold solution of—

Potassium dichromate	1 ounce
Water	15 ounces

In both cases it is well to pass the sensitized paper through a copper-plate or lithographic press, as a fine, smooth surface is thus given it. The paper may be subsequently floated on a solution of albumen and bichromate of potash, made as follows:—

Albumen	3 dr.
Ammonia	10 grains
Potassium bichromate	10 ,,
Water	5 dr.

The use of this will be apparent when the development of the transfer is considered.

The sensitized paper will keep from about a week in cold to one day in hot weather.

The negative should preferably be perfectly opaque in the whites, and no clogging or deposit must mar the transparency of the lines. It will be found that great pressure is required in the printing-frame to bring the paper and the negative in close contact throughout. The difficulty is increased considerably if the plates are not perfectly flat; hence, for these negatives, patent plate is recommended.

The amount of exposure to be given requires great judgment. With paper of a most sensitive character, and with a negative in which the whites are extremely dense, and the lines perfectly transparent, from half a minute to two minutes' exposure in bright light will suffice, whilst an hour may not be too long in dull weather. The surest indication of proper exposure is that the lines should appear of a dark reddish-brown on a yellow ground. Should a negative be weaker in some parts than in others, the weak parts may be shaded by tissue paper, or paint applied on its film side.

The prints have now to be coated with greasy ink. At Southampton the following formula for the ink is used :—

Lithographic printing ink	8 ounces
Middle varnish	4 ,,
Burgundy pitch	3 ,,
Palm oil	½ ounce
Wax	½ ,,
Bitumen	1 ,,

The ink and varnish are first well ground together with a muller or stone slab. The Burgundy pitch is next melted over a clear fire till the water is driven off. The wax is next added to it in small pieces, and finally the palm oil. These are well stirred together. When properly heated, the vapour from the mixture should catch fire if a light be applied, and then the bitumen is added, and the contents of pot ignited again. The ink and varnish are now added, little by little, the stirring continuing the whole time. The pot is now taken off the fire, and when the contents are cooled they are poured into tins for storage. The condition of the ink is of the greatest importance. It must not be too soft, otherwise the sponge used in development will become cloggy. If the ink be too hard, it will be difficult to develop at all; in this case more palm oil should be added.

To commence inking-in the print, a small quantity of the ink should be taken, and laid upon a flat stone slab, and melted with turpentine sufficient to give it the consistency of honey. This is well worked with a lithographic roller on a smooth stone, or its equivalent, to a fine even surface. A print is now taken and laid face downwards upon this inked stone, and is passed once or twice through the lithographic press. On carefully raising the paper, it will be found to have taken a fine layer of ink, through which the detail will be faintly visible by transmitted light. The coating of ink may also be given by a sponge or hand-roller, the paper being pinned firmly on to an even board, face uppermost. The finer the layer of ink, the better will be the developed print. These operations should, of course, be carried on in non-actinic light.

The print is now *floated, inked surface uppermost*, on water of about 90° Fah. It is allowed to remain on this till the lines are seen in *bas-relief* on a swollen-up ground. It is next transferred to a sloping zinc or glass plate, and warm water of about 150° is poured gently over it. The soluble gelatine is removed by *gently* rubbing with a very soft sponge; but should the inked soluble gelatine not leave the paper entirely at this stage, the prints should be *soaked* in warmer water for about an hour, when the sponging should be repeated. When the sensitized gelatine is moistened it becomes almost insensitive, consequently those operations may be performed in ordinary weak daylight. A constant flow of water from the sponge must be kept up to remove the inky gelatine after it is loosened, otherwise stains on the paper ground may result. It should be borne in mind that the utmost care is required in the sponging; if the sponge be roughly handled, the fine lines will be removed, and spoil the print for transfer.

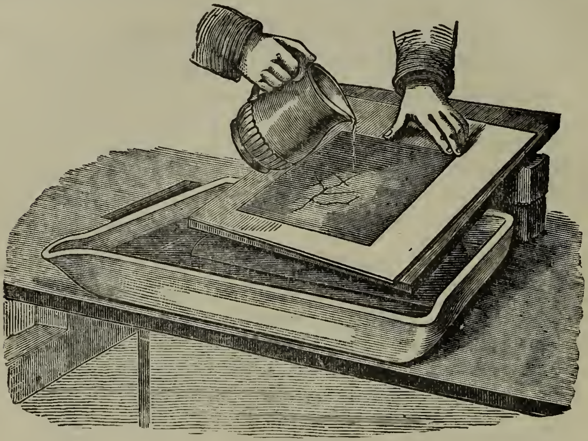

Fig. 34.

The prints, when freed from the soluble gelatine and ink, should be well washed in dishes of cold water, and hung up to dry. They are then ready to transfer to stone or zinc, but it is better to leave them a day, before the transfer is made.

If an albumen surface has been given to the transfer, the paper may be developed by floating on cold water till the gelatine is swelled as before. The application of cold water from a jug, and a gentle sponging, will remove the soluble albumen, and with it the ink.

To make a Transfer by Papyrotype.—Any tough paper is coated with a fine layer of gelatine, and subsequently treated with chrome alum or alum. It then receives another coating of gelatine of the same formula given for the Southampton method, substituting flake gelatine (for cheapness' sake) for the fine cut. The printing is not carried on to such an extent as in that method, but the lines must appear of a delicate fawn colour on the yellow background. After withdrawal from the frame, the print is drawn through cold water, and is then squeegeed down on to a smooth zinc or pewter plate. If found necessary, the edges may be secured by strips of paper and india-rubber solution, as for the heliotype process. The superfluous water is then blotted off, and a gelatine roller (of not too adhesive a character) is charged with ink. At the photographic department of the Royal Arsenal, they use what is termed a velvet roller, which is a lithographic roller covered neatly with a piece of velvet. This application of velvet seems at the time to have been regarded as a discovery, but it was used in the early days of heliotype, and discarded as not cleaning the whites of the picture sufficiently, being not quite adhesive enough. Our readers may try the velvet roller if they fancy it. It is necessary that the seam be very carefully made, as otherwise it shows marks in rolling up a transfer. It answers very admirably when the whole surface of the paper has to be inked over, and the whites then sponged away, and could be adopted in the Southampton mode of preparing a transfer. The ink is made as follows:—

Best lithographic chalk ink	4 parts
Palm oil	1 part

A small portion of the ink is spread upon a stone slab as in ordinary lithography, and after the roller has taken an even coating, it is applied to the paper. The gelatine has only absorbed water where it has been unacted upon by light; consequently, the lines alone will take the ink, the "whites" remaining free. After the paper has been well charged with ink, it may be necessary to pass the roller smartly over the surface to remove any scum that may be adherent. The finished transfer will be found of the most delicate character, and possessing great sharpness.

It is essential that but very little of the bichromate of potash should leave the paper, as the success in transferring mainly depends upon its presence. The transfer print is hung up to dry, and is then again exposed to light. The whole surface now becomes insoluble, and on re-damping, previous to placing on the stone, it has no tendency to stick, nor will the gelatine be squeegeed away by the pressure of the scraper in the press. There will still, however, be sufficient adhesiveness left to retain the paper in position. It will be noticed that this process has the following advantages:—

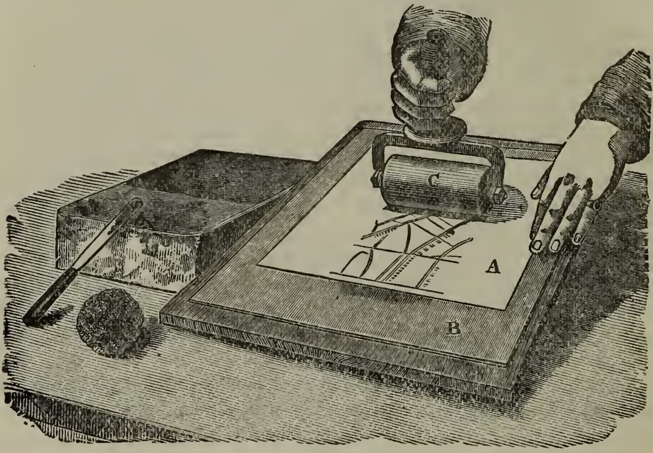

Fig. 35.

1st. The ink which forms the lines is not left on ridges of gelatine, as in the Southampton method.

2nd. There is no danger of removing the ink from the fine lines.

3rd. The ink may be applied till a satisfactory result is obtained.

4th. Two inks may be used of different consistencies; the thick ink will give solidity to the thick lines, whilst the fine lines will take a thinner.

5th. The surface of the transfer will have no tendency to slip, as the whole is partially adhesive.

Captain Waterhouse's Process.—In the Surveyor-General's Office in India, Capt. Waterhouse found that papyrotype did not come up to his expectations, probably owing to the heat of the climate, and he introduced a modification of the Southampton method, a description of which is taken from a communication to the Asiatic Society.

Paper is coated with two coats of gelatine and potassium dichromate as in the Southampton method, and is put away to harden and to become insoluble. When required for use, it is coated with a mixture of gelatine and potassium dichromate of about one-third the usual strength, and is then exposed to light, and inked in the usual way.

Instead of allowing the gelatine to harden by keeping, the hardening action may be hastened by allowing the light to act on the back surface for a minute or two. This may be done either after the print has been obtained, or after the preliminary coating has been given to the paper. It has been found that this method has the advantage that a base of insoluble gelatine remains on the paper and retains the finest lines, whilst the fresh coating preserves the clearness of the ground. If the underneath gelatine be not well hardened, the gelatine tends to stick to the stone or zinc, and the soft gelatine is liable to spread over the lines and to prevent their transfer. The ink is removed by cold water and a sponge, leaving the lines crisp, and the space between them free from scum.

Preparation of the Stone and Zinc Plate, and Mode of Transparency.—It is not proposed to give a detailed description of the apparatus for lithography, or zincography, as a respectable manufacturer will supply them of a proper character. A list of the articles necessary to procure is, however, given at the end of the book.

Both lithography and zincography depends on the property that a calcareous stone or mulled zinc plate possesses for absorbing or holding water, and on the fact that the grease is repelled by water; thus, where there is grease on a stone or zinc plate (present through accident or design) the water is repelled. If a roller now be charged with greasy ink, and passed over the surface while still damp, the greasy ink will "take" in those protions where grease was originally on the surface, whilst the other portions remained unaffected. The slightest trace of grease on the plat is sufficient to attact the ink from the roller.

Preparation of the Stone.—To prepare a lithographic stone for taking the transfer from a drawing, if the surface be uneven, or if a drawing has previously remained on for a considerable time, it may be necessary to grind it down, either by a stone, or by an iron levigator. In both cases fine silver-sand is sprinkled between the two surfaces, moistened with water. When the old work is removed, and the surface level, it is thoroughly washed with clean water, and polished with soft pumice-stone. The pumice-stone is moved backwards and forwards till all grain is removed, when it is again washed with a sponge and water, and finally brightened up with snake-stone. After another washing it is allowed to dry, when it is ready to receive the transfer. The polishing with pumice and snake-stone will take about a quarter-of-an-hour.

Preparations of Zinc Plates.—The zinc plates are supplied by manufacturers, of proper weight, and ready planished. They should be about 10 B W guage. To be prepared for receiving a transfer, they must be grained. Brass founders' moulding sand is the best form of sand to use, as others, particularly silver-sand, is apt to scratch the plate, and, prior to use, the sand is sifted through a fine sieve of about 150 holes to the linear inch. A zinc muller is used to grind the surface after the sifted sand (moistened to the consistency of a cream with water) has been sprinkled on the surface. It is worked slowly round and round with a spiral motion, till the surface after washing appears of a uniform dull grey tint. Any traces of previous work must be obliterated, and all scratches must be ground out. The mullers should be kept free from all accidental grit, and be carefully cleaned before use. The zinc plate whilst mulling may be laid on any flat surface. A plate should be mulled immediately before use.

Transferring to Stone or Zinc.—The stone is slightly warmed either before a fire, or, what is more expeditious, by pouring over the surface a kettleful of boiling water. The heat in this latter case dries the stone, and leaves it sufficiently warm, though there is a danger of the heat being too evanescent. The transfer is *slightly* damped, either by a moist sponge,* or by

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* The top surface of the transfer should never be sponged.

damping a sheet of blotting-paper, which is placed at the back.

Whilst this is taking place the stone is placed on the bed of the press, and the first operation is to ascertain that the scraper is perfectly true. Should it not be so, it may be adjusted by placing a piece of sand paper on a perfectly flat surface, and rubbing it down till it is perfectly level. The stone should now be "pinched" by the lever between the bed and the scraper, a piece of clean paper protecting its surface from the leather tympan. If the same amount of pinch be apparent at all parts of the stone, it is ready for use. If one end has less pinch than the other, the former must be raised by laying under it a few folds of paper, taking care that the folds gradually taper off as they approach the centre of the stone. The stone must next be passed two or three times through the press, in order that it may take its final bearings, after which the transfer is laid on the stone by two corners, and a couple of sheets of paper* are laid over it. After the tympan has been brought gently down, the stone is passed through the press two or three times. The amount of pinch given should be light for the first pull, it being increased for each subsequent one. The tympan is now raised, and if the transfer adhere tightly to the stone, the scraper may be reversed, and the stone is passed through the press a couple of times more. In order to remove the transfer paper it may be necessary to soak it with water. This done, the surface of the stone is moistened with gum water, and allowed to dry and cool. This is most important, as if it be used too fresh or whilst warm, the lines may spread, and give coarse and broken work.

The stone is fixed on the press, and the gum is washed off with a soft sponge, and the moisture distributed with a damping or cheese cloth. Ordinary lithographic ink having been worked to the consistency of honey, a little is laid on the roller and worked about on the ink slab till a fine even layer is spread over its surface. *Whilst the stone is moist* the roller is passed over it from time to time, fresh surface being brought to bear on the work. By this procedure it will be found that the lines take the ink. If a slight scum appears whilst rolling, it is probable that the stone is not sufficiently damp. A fresh application of

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* Preferably a piece of transfer paper.

the sponge and damping cloth, and a small roll, will lift it, leaving the surface clean. The stone is next slightly etched, to prevent spreading of the lines. A very dilute solution of nitric acid in water effects this. A sponge moistened with this should be passed over the surface, and, after leaving it for two or three seconds, fresh water should be applied with the damping cloth. A little gum-water is then applied, wiped off, and the inking proceeded with again. It may happen that all portions will not take the ink alike—that portions are weaker than others; in this case, over those parts should be spread thick gum, and *through* it should be rubbed a little palm oil, spread on a small square of cloth. This *generally* gives the required intensity. Impressions are now pulled, inking-in between each.

For zincography the process is very similar; the transfer is damped and passed through the press as above, the zinc plate being screwed on to a flat block of hard wood, so as to lie evenly and to be of sufficient height on the bed. When the transfer is removed the plate is well washed, and fanned dry. An etching solution is made thus:—

Decoction of galls	1 quart
Gum-water	3 quarts
Phosphoric acid	3 ounces

The decoction of galls is prepared by soaking four ounces of bruised Aleppo galls in three quarts of cold water for twenty-four hours; the water and galls are then boiled together and strained. The phosphoric acid is prepared by placing sticks of phosphorus in a bottle of water, the ends of the sticks being exposed to the air for some days. The etching solution is brushed on the plate with a broad brush, and allowed to remain a few seconds; the excess is wiped off with a cloth, and the zinc plate is fanned dry. It is then washed and rolled up as before. The first few impressions, either from stone or zinc, are generally feeble, and may have to be rejected.

A Gum Process.—Take Rive paper, and brush over it a solution of—

Picked gum-arabic	25 grains
Potassium dichromate	85 ,,
Water	1 ounce

Hang it up to dry. This will be accomplished in about half-an-hour in warm weather.

The sheet of paper must be placed under the negative as usual, and exposed to the light. When every detail is clearly seen, the paper should be withdrawn.

Take ordinary printing-paper, and soak alternate sheets in water, blotting the excess of moisture off in blotting-paper. Make these in a pile (about six sheets of moist and dry will be sufficient). Place the printed paper on the lithographic stone or sheet of mulled zinc, place a dry sheet of paper on its back, and then on it place the pile of damped paper. Finally, place a sheet of zinc or other flat surface on the top. The stone or zinc plate and its load should next be pressed under an ordinary book-binding press, and a considerable pressure brought on to it. It should be left under this for half-an-hour.

The paper is then removed from the stone. Those parts of the gum which were rendered insoluble will leave the stone with the paper, the remaining portions adhering to it. After thorough drying away from light, a little oil is poured or brushed over the surface. The gum protects the white portions of the prints from its action. The stone may be cleaned from the gum with a sponge and tepid water, and the ordinary lithographic process may then be proceeded with.

The process is simple, the drawback being that the gum penetrates to a considerable depth through the surface of the stone, rendering the preparation for fresh work tedious.

Photo-Lithography in Half-Tint.—Very many attempts in former years have been made to produce relief block, and lithographs in half-tone, but with a limited amount of success. The trials, however, have revived during the last couple of years, and with better success. The object to be aimed at is to give a grain to the transfer, so that it will not clog on the stone when transferred to it, or to the block after it is bitten in. This may be arrived at in one of two ways—either by giving a grain to the transfer paper itself, or by interposing network of some description to cut off the light in some regular manner. The former method is the most scientific, and can be effected by adding to the transfer paper some chemical which will give a reticulated film. Such a substance we have in tannin, and in some kinds of gum resins; or, again, it can be given by taking an ordinary photographic print, passing its face over a roughened surface, and re-photographing it, when the hills and depressions will give the necessary grain on the negative. If to the bichromate solution matter that will crystallize be added before mixing in gelatine, the same thing will occur, and we have seen some transfers in which the addition made was of the simplest description, and which yet gave admirable results. In other words, we only have to increase the dimensions of the grain found on a heliotype skin in order to arrive at what is required. Very coarsely-ground plate glass will answer if the paper be prepared by giving such a plate a thin solution of gelatine (after waxing the plate as in the heliotype process), and, when set, squeegeeing a sheet of damped paper on to it. On removing the gelatine film, the irregularities will be found to suffice. There are a variety of ways, indeed, in which the grain can be produced.

A network may be produced by photographing parallel lines which have been very finely ruled on paper, and then from such a negative taking prints on a dry plate by contact in several positions. Net work may be thus produced of almost any pattern.

Fig. 36.

If such film be removed from the glass by the method given at page 187, it can be placed between the negative to be printed and the bichromated gelatine paper. Thus two images are impressed at the same time. It will be seen that, in this case, the transparent parts of the negative are crossed in fine opaque lines, which, on printing, cause the surface to remain unaltered at these parts, and consequently do not take the ink on rolling up. By this artifice many good lithographic prints in (apparently) half-tone can be obtained, and if two or three patterns are used at different parts of the negative, very good results can be obtained.

CHAPTER XLV.

PHOTOGRAPHIC ENAMELS.

There are two methods of producing photographic enamels which have been practised in this country; the one by what is called the dusting process (similar, in fact, to the powder process, described at page 257), metallic powder being employed instead of the plumbago; whilst the other is dependent on the production of a transparency in collodion, the image being toned by various metallic compounds. The first process will not be described, as it is believed that the second is capable of giving better results.

A muffle for this purpose is absolutely essential. A form for placing in an ordinary fire is supplied by many dealers; but, when feasible, it is advisable to have one which is heated by gas, as there is no danger of discolouration from smoke, sulphur, &c., which is sometimes the case when coal or coke is the source of heat. Fletcher, of Warrington, supplies a most excellent gas furnace for the purpose (see fig. 37). It can be fitted on to any ordinary gas supply, and attains sufficient heat in a quarter of an hour to fuse any enamel placed within the muffle.

The first step in the production of an enamel is to produce a fully-developed transparency of the subject to be copied. This is secured in the camera in the usual way, or by contact printing, and when fixed should appear very vigorous, though with half-tones of a most delicate character. The next operation is to detach the film from the glass plate. This is effected by placing it in distilled water (to which, if the film be refractory, a little dilute sulphuric acid has been added), and after a thorough soaking it can be removed by a camel's-hair brush, deftly applied at one edge. The sulphuric acid is sometimes an advantage if the collodion be tender, as it toughens it; but great care is requisite to ensure that all traces of it are eliminated before proceeding further. The writer has in many cases toned the transparency before detaching the film from the glass, but the action is slower, owing to the fact that only one surface is open to the deposit of the metal.

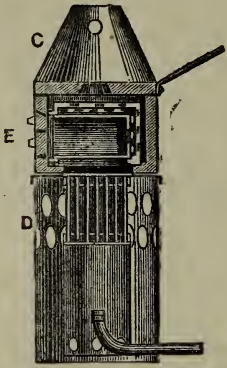

Fig. 37

E is the muffle door closed with fire-brick (shown in section); D shows the draught-holes opposite the burners, which are a series of pipes; C is a movable piece to which is attached a chimney. The muffle part can be removed, and an alternative portion is supplied for heating crucibles, &c.

There are several toning solutions which are all effective, though the colour of the finished enamel varies according to the metal employed. It may here be remarked that there are two methods of burning a picture on an enamel—one in which the image is absolutely burnt into the plaque; the other in which a soft flux is melted over the metallic image, giving it merely a glaze. The first plan is real enamelling, the metal forming a compound with the composition employed; while with the latter the image is merely superficially protected, and is not, therefore, so likely to resist injury. For absolute success with the first method it is merely essential that all silver should be entirely eliminated from the image; for if a true silver compound be formed, the image on burning will have a dirty canary colour, which no subsequent treatment can efface, though by regulating the temperature some operators can burn-in just sufficient to cause the image to sink into the enamel. The composition of the plaques materially affects the tone, hence there is often a discordance in the results obtained by different operators, unless the same materials be used. With plaques supplied by some manufacturers the platinum toning bath gives a rich velvety black colour. The toning bath employed is—

Platinum tetra-chloride*	1 grain
Water	20 ounces

to each pint of which 4 drops of concentrated nitric acid are added. This gradually converts the film of the image into silver chloride, and causes a consequent deposition of platinum. As one equivalent of platinum displaces four of silver, the reason why a rather dense transparency is required is apparent. The toning operation can scarcely be continued too long when the transparency is of proper intensity.

Another toning bath, suggested by Herr Grune, is to tone first with platinum, and then to remove the film to a solution of uranium ferricyanide. Half a grain of uranium nitrate and half a grain of potassium ferricyanide are dissolved in a pint of water, and this solution is employed. When a slight browning action is observed, the fused image will have a sepia brown tint. Iridium chloride of a strength about the same as the platinum chloride is also employed by some enamellers with very good effect, the tint of the picture produced being a delicate grey.

After well washing,† the film should be treated with ammonia solution, half ammonia and half water. This dissolves out the silver chloride, and leaves an image formed of metallic platinum and silver. To eliminate the latter, after thorough washing in distilled water, it is treated with nitric acid and water (half acid and half water). This finally frees the image of all traces of silver if it again be thoroughly washed.

The picture, thus finished, is allowed to remain floating in a dish of distilled water, and when the plaque is brought beneath

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* Previously neutralized with sodium carbonate.

† The film must be thoroughly well washed, in order to free it of any trace of the platinum solution; otherwise, by the subsequent treatment, a deposit of the metal may take place on the whites, and spoil the picture.

it they are both brought out of the water together, the film clinging to the surface of the plaque.

The film is trimmed by a penknife so as to just cover the edge of the latter, and after a few strokes of a fine camel's-hair brush, collodion and enamelled surface will be found to adhere together without crease or wrinkle. After drying thoroughly, the plaque is placed on a small sheet of cast iron or a small brick, and placed in the muffle, and the heat applied. The process of burning-in can be readily watched, and the instant that it is complete may be judged by the appearance of the surface of the enamel. First, the collodion film* disappears, next the whole plaque becomes red hot, and the image seems to disappear; a few seconds after this effect is observed, it should be withdrawn, and it will be found that the burning-in is finished.

The enamel appears dull and devoid of gloss, and it is consequently necessary to apply a glaze to it. The glaze employed is that known as *soft glaze*, as supplied by various china manufactories. This can be shaken up with plain collodion, and so emulsified that on coating the plaque the image is completely hidden by the white surface due to the fine powder. When dry, another burning is given, but only to such an extent that the soft glaze becomes liquid, after which it is withdrawn. It frequently happens that two or more glazings are required before the right lustre is obtained.

The art of enamelling is practised by very few photographers; those whose productions are worthy of notice could be named on the fingers of one hand. The method given above is founded on that of Herr Grune, and it is believed that most enamels are produced in a somewhat similar manner.

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* If the sulphuric acid used in the first soaking to detach the film has been too strong, it often explodes, and carries away the image with it.

CHAPTER XLVI.

PHOTO-RELIEFS AND PHOTO-ENGRAVING.

Photo-Reliefs.—The production of satisfactory photo-reliefs of etchings, &c., has long been a desideratum in the printing trade, and many attempts have been made to secure such. The following answers well for their production in zinc.

A transfer in hard transfer ink from a negative is made as if for lithography and zincography. A one-eighth of an inch zinc plate is then thoroughly mulled as described at page 284, after which it is rubbed down to a smooth surface with pumice, and then with stick charcoal. The appearance of the plate should be such as to be almost polished, and all visible grain should be absent, particularly if the work to be reproduced be fine. The transfer is then placed on it, and passed through the lithographic press in the ordinary manner, and a good firm impression left on the prepared surface. The plate is now dusted with fine resin or colophony (the dust being passed through a muslin bag to prevent any lumps adhering to the plate), all that does not adhere to the greasy ink being blown off. A solution of—

Hydrochloric acid	1 part
Water	500 to 750 parts

is next prepared, and placed in a flat dish which is sufficiently large to hold the plate, and which can be rocked mechanically. The solution should be of such a depth that when the dish is fully tilted in one direction the surface of the plate should be a little more than half bare. The surface of the zinc bearing the picture is next flooded with a dilute solution of copper sulphate (10 grains to the ounce), and a fine black deposit of precipitated copper is left.

In this stage we have a zinc-copper couple, the contact between the two metals being so complete that the voltaic action is able to decompose a variety of liquids hitherto not easily acted upon. The coppered plate is immersed in the acid solution, and an immediate evolution of hydrogen shows that an action is taking place, the zinc being gradually attacked where the copper is opposed to it. It should be remarked that the acid solution is so dilute that it has no susceptible effect on uncoated zinc, hence those portions covered by this greasy, resinous transfer ink are not acted upon. The dish containing the acid should be constantly rocked to cause the bubbles of gas to disappear, and on this rocking depends the success of the process. After twenty minutes in this solution, the slow evolution of hydrogen will show that the acid is nearly exhausted. The plate should then be withdrawn, and washed under the tap. It should next be warmed to soften the ink and the resin, and more ink should be rubbed into the lines, as is done in rubbing up a lithographic impression. The dusting process is again resorted to as before. The copper solution is applied, and after washing, the zinc is again immersed in an acid solution (this time of double the strength of the foregoing), and the same motion given to the dish. These operations are again and again repeated, the warmed ink and resin gradually running down the raised lines and filling in the close spaces. When a sufficient depth is given to the close lines, the large portions of the block which should print white may be sawn out with a fine saw. The zinc relief is then mounted on a wooden block for printing purposes. When printing off large numbers, zinc is liable to damage, and printers seem to object to this metal. Electrotypes may be taken from the zinc reliefs, and, when faced with steel, leave nothing to be desired.

It should be remarked that the employment of copper prevents local electrical action in the zinc when iron or other impurities are present, hence the metal may be that ordinarily to be obtained in commerce. The most successful worker in zinc, as far as the writer knows, is Gillot, of Paris, many of whose productions are undistinguishable from the best woodcuts. The economy of this method of producing relief blocks is the fact that two or three square feet of them may be executed at the same time, very little additional labour being required.

A very short way of obtaining blocks for relief printing is by treating a lithographic stone in a similar manner (omitting the copper solution), and using a hot iron for melting the ink and the resin. A mould is obtained from this in wax, paraffine, or gutta-percha, and an electrotype taken. Great depth is more easily obtained on a lithographic stone than on zinc if the manipulations are carefully attended to. Constant practice is required in these processes to ensure success.

Photo-Engraving.—There are various methods of producing photo-engravings which are employed by different firms; but, so far, the best seems to be that based on the original process of photography, viz., on the action of light on asphaltum or bitumen of Judea. This substance is dissolved in benzole or chloroform, and a thin coating given to the copper plate by flowing it over as collodion would be. When dry, the colour of the copper should be visible through the coating. The plate is then exposed behind a film, and after half-an-hour's positive sunshine, or its equivalent in diffused light, it is developed. The developing consists first in softening the soluble portion of asphaltum with olive oil, to which subsequently a little turpentine is added. This gradually dissolves away the asphaltum, and leaves the lines bare and ready for the action of the etching fluid.

The development must be very gradual, and the turpentine and oil washed away with water directly the lines are bare, otherwise the action of the solvents will continue on the parts which have been acted upon by light, and the image will gradually disappear.

The etching solution will be as follows :—

Potassium chlorate	1 part
Hydrochloric acid	10 parts
Water	48 ,,

After the developed plate has been immersed in this solution a short time, the weakest lines will appear to be etched, the stronger lines taking the "bite" quickest. When the former are judged to be of sufficient depth, the asphaltum is removed by benzole, and the plate is ready for the copper-plate press.

Photo-Engraving in half-tone.—The processes employed for this purpose are more or less secret. Fox Talbot was the first to introduce a plan by which it could be effected. His plan was as follows:—A transparency is made from a negative, and this is placed in contact with a copper plate which is coated with

Gelatine	¼	ounce
Saturated solution of potassium dichromate	1	,,
Water	10	ounces

In Talbot's directions it was directed that the plate should be dried by means of heat; it may, however, be dried spontaneously. A very thin coating of gelatine is all that is required. When the printing is complete, a solution of camphor and resin in chloroform is made, and the sufrace coated with it. The chloroform evaporates, and leaves a film of resin and camphor. The plate is gently warmed, and the camphor evaporates, leaving the resin in minute particles adhering to the surface of the gelatine. The plate is next etched by a solution of ferric chloride and water, viz.,

Saturated solution of ferric chloride	6 ounces
Water	1 ounce

A small quantity of this is evenly brushed over the plate, and in about a minute the etching commences, and is seen by the etched parts becoming darker. It spreads rapidly, and the details of the picture gradually appear. The greatest care is requisite in having the etching solution of right strength. If the etching commences too rapidly, the solution must be kept more saturated with the ferric chloride, less water being added. If the strength be too great, the etching commences but slowly. The use of the powdered resin is to give a grain to the plate, and in one process Fox Talbot used fine netting to give the desired effect in printing. In both cases the etching fluid did not act where such grain was formed. When the etching is considered complete, the plate is dried with a cloth, and all action stopped by immersing it in water. We recommend that to the water a little sulphite of soda be added, as this reduces the iron salt to the ferrous state, and thus stops all action.

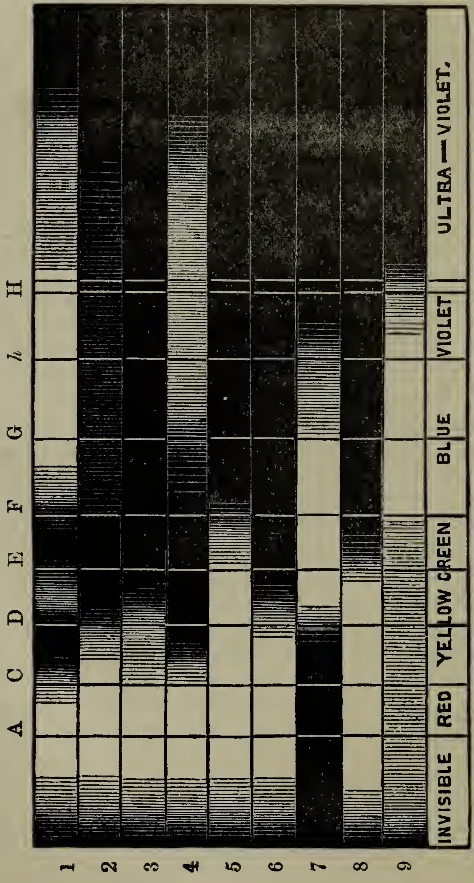
Goupil's process is a secret one, and, therefore, we cannot say emphatically on what principles it is based. It seems to be, however, founded on making a gelatine image, and then electrotyping it.

CHAPTER XLVII.

THE DARK ROOM AND ITS FITTINGS.

Illumination of the Dark-Room.—In considering the subject of the dark-room, the purposes for which it has to be used must be taken into account. Perhaps the most important point is the consideration of its illumination. A little reflection will show that this depends entirely on the kind of work which has to be undertaken in it. Thus, a reference to page 5 will show that for the wet process the light may be of such a colour that all the rays from the red to the green may be allowed for illumination; whilst with a gelatino-bromide plate no visible rays are absolutely safe, but that those from the orange to the red (D to A) will have least effect, and that the more the light is confined to the lower end of the spectrum the safer it will be. For silver chloride even the blue rays might be admitted, as well as the green, yellow, and red. Fig. 38, page 298, shows the light which passes through different glasses and dyes. Looking at No. 5 it will be seen that, for wet plate work, when bromo-iodide of silver is used, it is a safe light; whilst for pure ordinary bromide No. 6 would answer. For bromide as formed in gelatine plates neither one nor the other would be admissible. In this case a combination would have to be made, and this might be a combination between Nos. 2 and 6, for the hurtful light which would pass through the one is cut off from the other. Again, a combination between No. 8 or No. 3 and No. 4 would equally answer, or between No. 6 and No. 4. A caution is here necessary. Dyes are affected by light bleaching to a very considerable extent. If, therefore, the windows of the dark-room be covered with dyed paper, or with dye in varnish, it should be watched to see that it has not bleached sufficiently

Fig. 38.



1, Cobalt glass; 2, ruby glass; 3, chrysoidine; 4, magenta; 5, flashed orange; 6, stained red glass; 7, bottle-green glass; 8, aurine; 9, quinine.

to become dangerous. The safest plan, perhaps, is to glaze the window with stained red glass, and then to have a curtain over it of a ruby colour. The most convenient material for the latter with which the writer is acquainted is bookbinders' red cloth. This, combined with the stained red glass, is a protection with any moderate, against any hurtful, light. It must, however, be remembered that strong red light might affect a gelatine plate, so that if the sun shines on the window during the preparation of a gelatine plate, or during its development, fog might result. At the same time a careful study of Chapter IV. will show that when a plate has been exposed to white light, and is then exposed to red light, a reversing action takes place, and that the image will disappear under its influence. For this reason, then, an exposed plate should be carefully excluded from as much light as possible till development has absolutely commenced. The advice we give is to glaze the dark room with stained red glass, and, when necessary, have a blind or curtain of ruby material to draw over it. Ruby glass alone is not a sufficient protection, since blue light is apt to permeate it. For comfort, the more light of the proper quality admitted, the better the work that will be done.

Recently there have been many advocates for what is known as canary medium, which is paper impregnated with lead chromate. In situations where direct sun does not beat against the window, two thicknesses of this material may be used for developing purposes; but for preparing plates where the room is illuminated by daylight, we do not recommend it. There is a common range paper of the colour of the binding wrapper of this work which cuts off more of the green light than the canary medium, and two thicknesses of this placed over a window facing north may be used with impunity for developing purposes. For coating plates with gelatine emulsion we advise that artificial light be used, as it is safer in many ways.

Artificial Light.—If artificial light be required, the best plan is to have a gas-flame or lamp outside the window; but this is only sometimes possible. In case it is possible, a little window should be cut in the wall, on the left or right of the sink, and glazed as before shown, through which artificial light may be used.

A useful screen for developing dry plates at night by candlelight can be made as follows:—Take a sheet of cardboard of the size of about 2 feet by 1 foot 6 inches. Lay off from the 2 feet side distances of 8 inches from each corner, and with a penknife cut half through the card in a line parallel to the ends. These will form flaps, which can be folded round to meet, forming a hollow triangular prism. From the centre portion, and

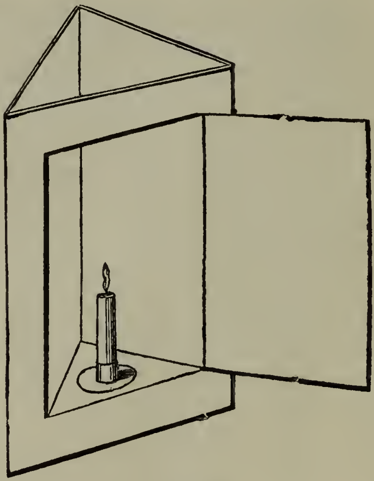


Fig. 39.

3 inches from the bottom, mark out a rectangle of 6 inches by 12 inches; cut round three of the sides, but only half cut through the right-hand side, the penknife being applied from the inside of the screen. This will allow a square flap to open towards the outside.* On the inside of the opening may be pasted or hung two folds of orange paper. A candle can be enclosed by the screen, which will stand self-supporting in front of the operator. Reflected light from the ceiling can be stopped by placing over the top of the screen a piece of tin, round the edges of which ventilation holes have been pierced, or even a newspaper will do when the candle is not too long. When packed for travelling, the flaps are folded up, and it can be placed in the portmanteau with the greatest facility. For

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* The three sides may be treated in the same way, and an all-round illumination thus secured.

safety, it is, perhaps, advisable to blacken the inside of the cardboard.

Such a lantern in an enlarged form may be used with a gas jet, and will be ample to illuminate any moderately-sized dark-room. We prefer, for illuminating a dark-room by artificial light, a translucent medium, such as paper, for the reason that the source of illumination becomes a surface, and in consequence, the shadows, which would be deep with a point of light as a source, are lighted up more or less; hence the illumination appears more perfect. Canary medium may be employed in two thicknesses, and is a pleasant light to work by, though we have a preference for the two thicknesses of orange paper, although the light is a little redder. Direct light from a luminous source through proper glass is, however, at times desirable, as, for instance, in examining a gelatine plate for opaque spots, which then are readily seen by light reflected from the surface, though they will not show by the light issuing through paper.

Size of the Dark-Room.—As to the size of the dark-room, we strongly recommend that it be as lofty as possible. The generality of dark-rooms are too small for health, and certainly for comfort, a mere cupboard often being substituted for a well-ventilated room of moderate dimensions. A certain amount of cubic space will be doubly necessary if many hours are to be passed in preparing plates and developing.

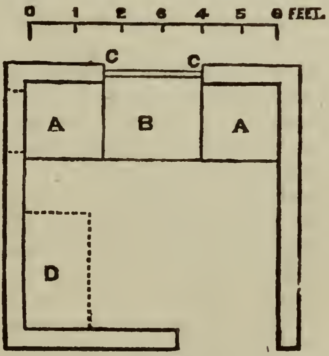

Fig 40.

The above figure shows a plan which will be found convenient. It is a room only six feet square, which, we think, is the minimum that should be allowed, if it is the only photographic dark den available for all purposes. A is a working table from 2 feet 9 inches to 3 feet high, and B a small lead sink 2 feet by 1 foot 6 inches in dimension, and 6 inches deep. The sides of the table should have a small inclination of (say) half-an-inch towards the sink, in order that all water may drain into it. The table may also be grooved with the same object, except a small portion on which the developing cups may be allowed to stand temporarily. The water is conveniently admitted by a stand-pipe, from the top of which springs a movable arm with a tap; at the extremity of the arm is suspended an india-rubber tube with a fine rose attached.

This plan enables a plate to be flooded with water without endangering the film, and the arm may be swung back when water is not required. A lid to cover B will give a table on which dishes during sensitizing paper and other necessary operations may be placed. D is a drying-cupboard (see Chapter XIII.).

We recommend that the walls and ceiling be papered with varnished paper, as then there is less fear of dust of whitewash settling on the plates. For gelatine work we prefer to have kamptulicon laid down, which can be easily scoured when requisite.

Fitments.—Shelves there should be in abundance, and also hooks on which to hang brushes, and so on. It is a golden rule in photography to remember that "there is a place for every thing, and that every thing should be in its place." Funnels, filters, and measures should not be kept in the dark-room, except what may be absolutely necessary, and no slop or spills of developer should be allowed to remain to dry up by evaporation, otherwise spots and all kinds of mischief may be expected to occur in developing either wet or dry plates. The door should be light-tight; a judicious application of india-rubber cording or list will often stop up any cranny through which light might penetrate. A curtain outside the door is often efficacious.

Dipping Baths.—Porcelain baths for silver nitrate answer well till the glaze gets cracked; they must then be put aside, or contamination of the bath solution may ensue. Glass baths in wooden cases (with water-tight top for travelling purposes) are to be most recommended, as the solution can be inspected from time to time; also any accumulated dirt on the inside will be immediately noticed. One precaution should be observed in selecting glass baths, viz., to ascertain that the wooden case does not fit tightly on to the glass. The bottom of the case and its top should be padded all round with thick felt, to prevent breakage by any casual jar. Ebonite is brittle and injured by heat, but it may be used in a mild climate. It is well, however, to wash it thoroughly in potash and water, then rinse with distilled water, and finally to put an old bath solution in it to season it before taking it into permanent use. Gutta-percha is generally too impure a material to be substituted for glass.

Dippers.—Ebonite dippers answer in a temperate climate, and are not liable to break. A hook at the back to catch the edge of the bath, which just prevents it touching the bottom of the bath, is an advantage. Any deposit thrown down is thus undisturbed. Makeshift dippers may be manufactured by cementing, with marine glue or bitumen, a small thick strip on to a long strip of glass. Silver wire dippers, perhaps, are the best, as there can then be no accumulation of the bath solution at the back of the plate.

Developing Cups.—Glass or white stoneware developing cups are superior to any other, in that they can be kept clean, and the amount of solution in them can be accurately seen, which is not the case with ebonite cups. In the field it is useful to have a couple of the latter ready at hand in case of accidents. For plates up to 10 by 8, the children's small tumblers, sold for about a penny, answer every purpose, and they are difficult to break.

Pneumatic Plate Holders.—There is no better plate-holder than the india-rubber globe pattern. It is convenient to have the globe enclosed in a cylindrical box open at the lower end. Remember to keep the plate-holder used for collodionizing the plate for that purpose alone.

Draining Racks.—There should be a draining rack in the dark room to hold negatives after development and fixing. A rack to hold a dozen plates is a useful size to have.

Measures.—A four-ounce measure in a developing room is often handy, as is also a minim measure. The latter should be selected with a broad base to stand upon, so as not to be easily overturned.

Developing Dishes.—The usual dishes used for developing are shallow ebonite dishes a little larger than the plates to be developed. These are very cheap, and, if protected from great heat, last well. They are better than the *papier mache* dishes, as in alkaline development the alkali is apt to dissolve off the varnish used in them. Collodion dishes as manufactured by Mr. Hart are very excellent, and have the great advantage that they are white. Porcelain dishes for small sized plates are perhaps better than ebonite for this reason; but for larger sizes, they are uneconomical, owing to the want of flatness of the bottom usually found with them.

Developing Cups.—A teacup is not a bad kind to use, since it is more readily seen in the dark-room than is glass.

CHAPTER XLVIII.

APPARATUS.

The Camera.—For out-door and landscape photography the camera should be of the lightest possible make, as far as is compatible with rigidity. That form which is known as "the bellows," with parallel sides, when properly made, fulfils these requirements better than any other. In it the lens remains fixed, whilst the ground glass is made to move to attain proper focus. This will be found of great convenience. *Every camera* should have a "swing-back;" that is, the ground-glass should be made to hang plumb when required, supposing the camera to be tilted. For hot climates and rough usage brass binding to the woodwork is recommended, and Russia leather for the bellows; cockroaches and white ants will not attack the latter.

For an amateur photographer, a camera to take an 8½ by 6½ is recommended as a very suitable size, though to many the 7 by 5 is recommended. There are many sizes of plates in the market which are absolutely hideous, the proportions either being too long in proportion to the breadth, or else too much approaching a square shape. We may instance for the former 7¼ by 4½, and of the latter 12 by 10. A good proportion is to have the length and breadth of a print of about 3 to 4 when trimmed. A camera should always be capable of taking views in which the greatest length of the plate is vertical. A long plate in such a case is a mistake. It is often said that prints may always be trimmed to satisfy the requirements of good proportion. As a matter of fact, ninety-nine out of every hundred prints are not to the size of the negative, and hence we insist on the proper shaped plan being used.

Figure 41 shows a good form of camera, introduced by Meagher, which the writer has worked with for many years. It is very light, and though it has gone through a battle with hot climate and inclement weather, it is still valued as an old and useful friend.

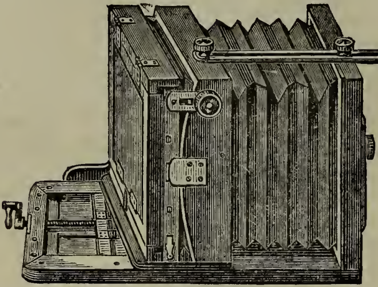

Fig. 41.

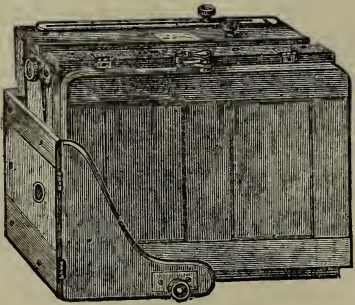

Fig. 42.

Fig. 42 shows the camera when folded up. Half-a-dozen double backs for dry plates, with the camera, can be well placed in a leather case, and will be quite within the weight for carrying.

It is necessary that such double backs should be carefully made, as the slightest inroad of light into them through any joints is fatal to the rapid plates now extant. The jointed part of the front of the slide should be hinged with leather, or it may be made in the form of the roller shutters. Any of the first-class camera makers will supply slides which are almost feather weights for small size, and at the same time perfectly light-tight.

Instead of double backs, "changing-boxes" are often used. They usually will contain a dozen plates, and by a simple mechanical contrivance any one of them can be made to slip into a properly constructed dark-slide without exposure to light. Fig. 43 gives the form of changing-box and slide designed by Sands and Hunter. Hare's changing-box is also a general favourite, and may be said to be the father of most of those which have been since introduced.

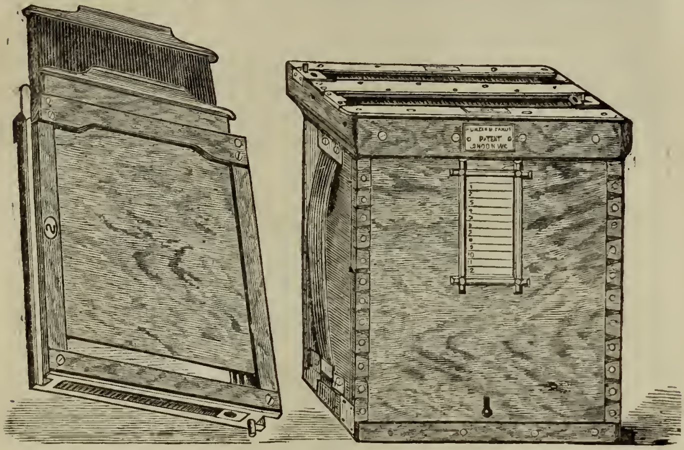

Fig. 43.

For our own part, we would never use a changing-box if light double backs were available, as any error in the cutting of the plates often leads to disaster in the changing. Care in selecting the plates before placing them in the box will, of course, avoid

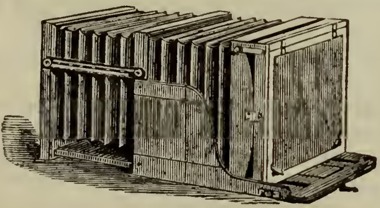

Fig. 44.

this, but we prefer the double backs, when the right size of plate being used forces itself on the attention.

Fig. 44 shows a camera by Meagher, which is adapted for copying purposes, occupying the same space, when closed, as fig. 41, but having an extra length, which is pushed forward beyond the ordinary camera front.

The cut is taken from an 8½ by 6½ camera, and the length of focus obtainable is 24 inches; whereas in the ordinary form, without the extra length, it gives about fourteen inches focus.

Another form of camera (shown in fig. 45) is one patented by Messrs. Rouch and Co. Fig. 46 shows its shape when shut up. It is very light, and has a double swing-back. The focussing takes place from the front.

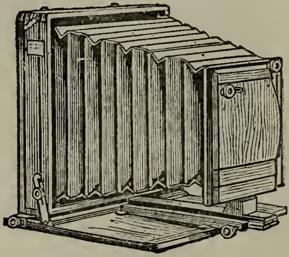

Fig. 45.

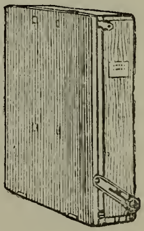

Fig. 46.

There are a variety of cheap cameras in the market which answer fairly well so long as properly handled; but our advice is to get a first-class camera at once, and it will prevent many failures and disappointments.

Before taking a camera into use, care should be taken that the inside of body is made *dead* black, otherwise reflections on to the plate may occur, giving a foggy appearance to portions of the negative. The mode of testing this instrument will be patent to all, the chief defect to be looked for being a want of coincidence of the rough surface of the ground-glass with the plane of the silver wires, &c., which support the sensitized plate in the dark slide. Perhaps as simple a method as any of testing this coincidence is to place a dry plate in the dark slide, open it back and front, and focus on the film; the slide is then withdrawn, and the focussing screen replaced; if the focus on the latter is correct, the adjustment is complete. Well-seasoned mahogany is the wood most suitable for a camera, and it should be borne in mind that polish gives greater durability to it.

For portraiture, a heavier camera may be used, as lightness is not essential in this case. The bellows form is not necessary, and a solid camera may be procured. For portraiture the lenses employed are usually heavier than for landscape work, and this necessitates a greater rigidity.

Camera Legs.—The camera legs for landscape work should be of such a length as will allow the lens to be raised some five feet or more from the ground. This rather exceeds the average height of the eye. There are various portable folding and sliding legs extant, from which a choice may be made. Rigidity and portability are the first considerations. In choosing legs they should be erected, when it will soon be seen whether they fulfil the necessary conditions. The top of the stand should be of proper dimensions to hold the camera steadily and without shake. When legs with a triangular brass top are chosen, it will much save the camera, and assist in giving steadiness, if top be covered with a flat disc of wood attached by wire. For portraiture the camera stand is usually made of a rising pedestal form, the adjustment for height being made by a rack-and-pinion, and a tilting motion in somewhat the same way.

*Lenses.**—For landscape photography a single meniscus lens gives the most brilliant picture. It should be more rapid than doublets, as the loss of light from reflection by the surfaces is the least possible. For architectural subjects the doublet or triplet lens is necessary, as the single lens distorts marginal lines. For a complete outfit for landscape work it is well to have four lenses:—(1) An ordinary single lens; (2) a wide-angle single lens; (3) a doublet lens; and (4) a wide-angle doublet. If only one lens can be provided, (3) should be chosen in preference to the others. For stereoscopic work the same applies. For portraiture a portrait doublet was invariably used until the advent of gelatine plates, on account of their great aperture in comparison with their focal length. With gelatine plates any lens may be used, and this is an advantage, as the "roundness" of the image can be equally well obtained. For instance, with a portrait lens, it is often difficult to get the eye and the back of

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* For the further consideration of the principles of lenses, see "Optics for Photographers" by the author of this work (Piper and Carter).

the head in focus without using a small stop, which is no objection when using a very rapid plate; but it can be equally well obtained by using a cheaper lens, such as the rapid rectilinear, which will bear a larger stop. By consulting a catalogue of some well-known maker, all information necessary for guiding the choice will be found.

English made lenses are, as a rule, recommended in preference to those of foreign make, though recently some Swiss and American lenses have been introduced which give very remarkable definition. Every lens should be achromatically corrected; that is, the chemical and visual foci are made to coincide. We recommend, when using a camera in the field, that the cap of the lens be tied to the body of the lens by a loose string. This will prevent its loss, which so readily occurs when it is unconnected.

Where stops are not "rotating"—that is, working round a pinion in the lens itself—it is a good plan to fasten them together with a brass pin to prevent their separation. We would wish to impress on the photographer the importance of keeping his lenses clean. As much as fifty per cent. of the light can be lost by the glasses being in a dirty condition, besides which definition is impaired, and also there is a great danger of fogging a plate from the lenses becoming luminous. Anyone who sees what effect a dirty window has on the light of a room will have noticed these effects.

The Dark Tent.—For operating with the wet process in the field it cannot be expected that there should be the same conveniences as are to be found in the dark room. The wants of the operator must be curtailed to some small extent, and this curtailment will be found of no detriment when his chemicals are in good working order, and when he has had sufficient experience at home to keep them so.

There are a considerable number of dark tents which are capital for field work. A box-tent is handy, as it will carry all the chemicals necessary for a day's photography. Rouch's pattern is excellent; that as modified by the writer has a few improvements, which add much to the comfort of manipulation. For hand carriage a tent should not weigh more than 25 lbs., including chemicals.

The lightest form of tent with which the writer is acquainted is that designed by Mr. F. Howard, and it is convenient for working in with plates up to 8½ by 6½. The essential principle of this tent is that it can be fixed on to the camera legs, and moved from place to place without the necessity of taking it down. It weighs only three pounds, and another seven pounds may be added for the weight of the box containing the chemicals. This additional weight of ten pounds to that of the camera is so little that it enables the photographer to work the wet process in the field without the necessity of employing a porter to aid him in carrying his traps.

A general idea of the tent when finished will be seen in the figure (fig. 47). The tent itself is hung from under the camera legs, and is in reality a bag. The head of the operator is kept outside the tent, and the operations are watched through a light-tight mask over the side in which the sleeves are shown. Mr. England's knapsack tent is also excellent both for wet and dry plate work. When a tent is erected it should, if possible, be placed in the shade, and the window must in any case be turned away from direct sunlight. Before trusting to a tent, it should

Fig. 47.

be tested by placing in it a sensitized plate for a couple of minutes whilst the window is closed. Should the plate remain unaltered by development, it may be taken for granted that the tent is fit for use.

A little tent we constructed for developing gelatine plates is shown in fig. 48. It consists of a framework of wood, which folds flat against a base-board. It can be made to weigh but 3 or 4 pounds, and can be readily packed in the portmanteau or basket used in carrying the camera when on tour. Over this framework slips a cover made of two thicknesses of turkey red calico and one of black. At the back is cut out a window, which is filled in with three thicknesses of orange calico, or two of turkey red and one of varnished orange paper. Plates can be developed or changed in such a tent in daylight, and it is placed on an ordinary table.

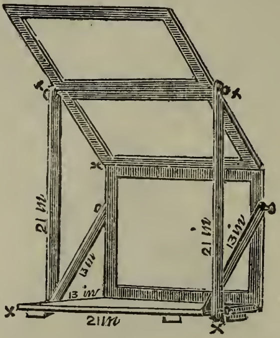

Fig. 48.

Draining Boxes.—A draining box which opens at the top and bottom is handy for out-door work. For economy of space each pair of grooves should be capable of holding two plates back to back.

Drop Shutters.—There are now in the market many excellen forms of drop-shutter, nearly every one of which is attached t the lens. Unless the camera be rigid, we hold that this is a mistake, as the fact of releasing any portion of a shutter alters the position of the centre of gravity of the whole apparatus, and induces a shake. This, in some cases, is only a theoretical objection, perhaps, but in others is doubtless practical. Again, some shutters act as diaphragms to the lenses, and thus the *full* value of the exposure is not gained, as much as half the light being lost. The theoretical form that a shutter should take is that the full aperture of the lens should be exposed for as comparatively long a period as possible, whilst the uncovering and covering should take place as rapidly as possible. With this in view, the writer designed a shutter shown in fig. 49.

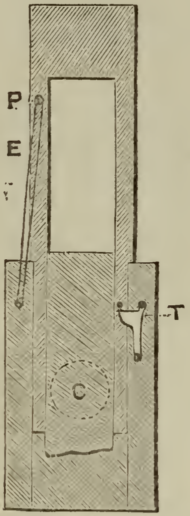

Fig. 49.

C is the aperture for the lens; P, the pin to which an elastic band, E, is attached; T, the releasing catch. In this we have a long drop-shutter, the velocity of drop being augmented by an elastic band. With an opening of five inches an exposure of about one-fifteenth of a second can be given. The shutter is attached to the lens by a velvet bag carrying an elastic band, and, at the moment of exposure, is held by the hand. Mr. Addenbrooke, Mr. Cadett, and some few others have brought out shutters which are very excellent.

Funnels.—Ribbed glass funnels will be found better than those made with smooth glass, as the air which is displaced can, with the former, find a ready exit. Gutta-percha funnels should be used with caution, as it is impossible to ascertain if they are clean.

Dry Plate Boxes for Collodion Dry Plates.—The form of dry-plate box we like best is that introduced by Colonel Wortley, and certainly possesses some advantages. The bottom of the box and top of the lid are fitted with quilted silk or fine calico, which firmly holds the plates. Two plates fit back to back in each groove. The arrangement for excluding light is also ingenious.

Packing Dry Plates.—To pack dry plates, resort may be had to the plan of separating one from the other by two strips of cardboard or thick paper bent zig-zag (as a hem is prepared for stitching), one at each end of the plate. Between each fold is placed a dry plate; the whole bundle should be bound round with twine, and wrapped in non-actinic coloured or opaque paper. Mr. F. Yorke supplies a machine invented by Mr. A. Cowan for packing plates in this manner. It is made for various sized plates. When using it we prefer to use thick red blotting-paper to any other material, as it is fairly pure, and, being soft, does not injure the plates. Another plan, which is suitable for amateurs, is to utilize the card boxes which are sent out by dry-plate manufacturers in the following way. Fig. 50 shows such a box in plan. A A shows four little blocks of wood of the height of the box glued to its sides and bottom. Between the ends of the box and the blocks little strips of cardboard can be inserted. A plate, shown by the dotted lines, is laid at the bottom of the box, face up; then slips of cardboard are inserted,

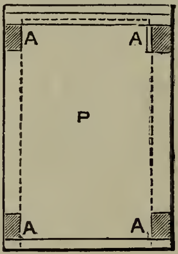

Fig. 50.

and another plate, face down, inserted; then one face up, then other strips of card, and so on, till the box is full. The box should only be a very little longer than the plate, but broader. By a little ingenuity any box which is larger than the plate can be adapted for the purpose. After the plates are thus packed, the box should be carefully wrapped up in several thicknesses of paper, one of which should be waterproof; or for this last may be substituted gutta-percha sheeting. A still more recent plan is to use soft cord, zig-zagging it round the entire end of each plate, and near the edges. This is a simple plan, and should be effective.

The following is the plan of packing plates introduced by Mr. England. He uses little frames of cardboard to place between his plates, and they are just large enough to be flush with their edges. Thus, for our sized plates (7½ by 5) we cut strips of cards 3/16″ wide, 7⅛ inches long, and an equal number of strips 5½″ long. Tough bank-post paper is gummed over with stiff gum, and allowed to dry, and little squares of about half-inch size cut out. A short piece and a long piece are laid together, or a pair of lines ruled at right angles to one another on a board, and when the square of gummed paper is made to adhere beneath them, and then deftly folded over, two sides of the required frame were made. One more long, and one more short piece, similarly treated, completed the frame. Four-sheet card is what Mr. England recommends. When the strips are cut, we make about thirty of these frames in an hour. The plates are packed alternately back to back and face to face, in the latter case a frame placed between them.

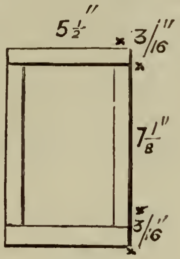

Fig. 51.

Plates may be packed in half-dozens, enclosed in two thicknesses of orange paper. The two packets are enclosed in pieces of black varnished paper, and then placed in boxes.

Boxes made of stiff millboard, and covered with varnished paper, are useful. The cover should cover both the top and sides of the boxes. They should not be too small, but be 1 inch longer and ½-inch wider, inside measurement, than the plates. A depth of 1½ inches will then take one dozen plates. Sands and Hunter have introduced what we may call a packing-book for gelatine plates. Fig. 52 shows the principle. The plates are separated from each other by thick soft paper which has been tested as free from all substances which may be hurtful to the sensitiveness of the plates. It is a very handy form, and one which commends itself especially to amateurs. Mr. B. J. Edwards packs his plates in cardboard grooved boxes. They are very nice to use, but rather bulky compared with the boxes necessary to pack plates by the other methods given. They have one great advantage, however, viz., that nothing is in contact with the film. They are thus suitable for collodion dry plates as well as for gelatine dry plates.

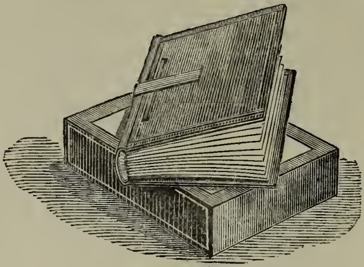

Fig. 52.

Apparatus for Long Tours.—The writer has often had queries put to him as to the size of apparatus most suitable for tours on the Continent and in hot climates. The reply is somewhat hard to make, as different conditions obtain in different countries.

For a Swiss tour, for instance, the writer would recommend a size of not more than 5 by 7½, as in pedestrian excursions the photographer will be able to carry his own camera and a dozen dry plates. In India, on the other hand, where coolies may be hired to transport baggage for a small sum, a 10 by 8 camera will not be found too large. It should be recollected that a man cannot walk for any distance in a mountainous country with more than 16 pounds of extra weight on him, and this should regulate the size of the camera and amount of apparatus taken with the photographer who desires to be independent of guides and porters.

APPENDIX.

To Purify Water for Photographic Purposes.—The importance of using chemically fit water in photography is not to be overrated. When distilled water cannot be obtained, resort must be had to purifying it to the best of our ability. The water should be roughly tested, to see what impurities it contains.

First add a drop of nitric acid to (say) one ounce of water; warm, and add a few drops of a solution of potassium sulphocyanide. A red colouration will show the presence of iron sufficient to be injurious in making up a silver bath. Next add to a fresh portion a little ammonia and ammonium oxalate; a faint precipitate will show lime present to the extent of about six grains per gallon. This may be neglected. If more than a trace of precipitate be apparent, the water must be purified from the lime. Next boil the water. A precipitate will show that the lime is present as a bicarbonate; if not, it is present as a sulphate. Magnesia is much less common in water than lime, and is present generally as sulphate (Epsom salts). Supposing all be present, and it is necessary to render them innocuous, we must proceed as follows:—First the water must be boiled, to get rid of carbonic acid, and to precipitate the carbonate from the bicarbonate of lime; this will leave about two grains per gallon of the calcium carbonate in solution. Next add ammonia till the water is slightly alkaline to test paper. This will precipitate any iron present (probably present as carbonate), leaving carbonate of ammonia and a little free ammonia in solution. Boil the water again till all the ammonia is expelled. Next add a grain to the ounce of water of silver nitrate, and place it in a blue or white glass bottle in the sun. This will precipitate the carbonates and chlorides present, and also the organic matter. Next add a few drops of a solution of barium nitrate to precipitate the sulphuric acid that may be present in the sulphates, and filter. The water thus purified will make an excellent bath water. If water be only required for washing dry plates, &c., it should be boiled and passed through a charcoal filter, when it will be fit for use.

Rain water should be passed twice through a charcoal filter to render it fit for use; that is, supposing it has been collected from the roofs of houses.

Water collected from snow is generally quite free from every hurtful impurity.

Distilling Water.—A still should be of a portable character. It should be ascertained that the worm of the condenser is not made of lead or any lead compound. The top of the still should be of such a shape that any water which may be projected upwards during ebullition is not able to travel down to the worm.

The neatest arrangement for distillation is a Liebig's condenser where gas is available, as since glass alone is in contact with the liquid, there can be no danger of metallic impurity finding its way into the distillate. It can be used for other distillations as well.

The condenser consists of two parts: first, a straight glass tube (*b*), bent at the ends, to which the flask is attached; the second, a jacket (*e*) surrounding the bulk of the tube as shown in the figure. The jacket has two short tubes (*d* and *e*) connected with it, *d* being that through which the cold water is supplied to the jacket, and *e* that through which the warm water

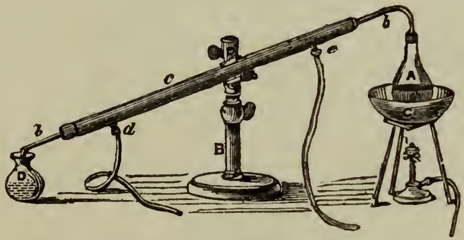

Fig. 53.

is forced out. A couple of india-rubber corks are bored to fit the central tube and to close the ends of the larger tubes. The condenser can be held by a clamp, B. The cold water can be supplied from a water tap, a pinch-cock being used on the india-rubber tube from *d*, so as to allow a very small flow ; or it may be supplied from a jar with a syphon arrangement, if care be taken to keep the bottom of the vessel above the highest end of the jacket. This still will be found useful for a variety of distillation. Care must be taken that it is kept rigorously clean, and if the distillation of alcohol be attempted, the first portion that comes over should be returned to the flask.

Evaporating Dishes.—The best evaporating dish is made of platinum or silver.* A substitute for the latter is to use one thickly electro-plated. It lasts a long time, and is not a quarter the price. Berlin porcelain is generally used, but dishes made of this material should be at least six inches in diameter. A metal dish is superior, however, as it enables a solution to be evaporated to dryness without burning the residue or fusing portions whilst the remainder is still liquid.

To Purify a Nitrate of Silver Solution by Boiling Down.—The bath should be placed in an evaporating-dish, and be evaporated down to dryness, and fused till all the frothiness that may be apparent has subsided. It will be seen that the organic matter has reduced a portion of the silver nitrate to metallic silver. When sufficiently cool, add enough nitric acid and water, 1 of the former to 10 of the latter, to re-dissolve this by the aid of heat. Now evaporate to dryness. The nitrate should again be re-dissolved in ten ounces of water, and be once more evaporated to dryness, when it will be found that it is fit for making up to strength, all excess of acid being dissipated.

Boiling down a bath rids it of the alcohol and organic matter, but leaves the nitrates of cadmium, &c., unchanged. When surcharged with these latter, the silver should be precipitated.

New Silver Nitrate Solutions from Old (*First Method*).—Dilute the bath to twice its bulk, and filter out the iodide of silver, which will be precipitated.

In the filtered bath solution place strips of copper or copper wire, and leave them undisturbed for twenty-four hours. This will throw down the silver in a metallic state, leaving the

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* When a silver dish is used, no nitric acid must be added.

copper and other nitrates in solution. Take two or three drops of the *solution*, and test for the absence of silver by adding a little solution of common salt to them. If no white precipitate appear, the conversion into metallic silver is complete. Carefully decant the supernatant fluid, and withdraw all the copper visible; wash the silver in three or four changes of water until the blue colour due to the copper nitrate is absent; all the other salts will be washed away with the copper nitrate. Place the metallic silver in a large porcelain dish, and add *gradually* one drachm of pure nitric acid (1·36, the strength of the British Pharmacopœia) to every 150 grains of silver nitrate (this can be estimated by the argentometer) in the original bath solution. The silver will gradually dissolve, but will be much aided by the application of heat. The solution will now have a greenish colour, from small particles of copper which have fallen, coated with silver, from the original wires or strips. These small particles of copper will be dissolved by the nitric acid, and will form copper nitrate. Boil down the solution to small bulk—till it begins to spurt. This will free it from any great excess of nitric acid. Next add distilled water to it till it has a slightly larger bulk than it had before boiling down. Next add silver oxide, little by little, till the blue or greenish colour has entirely disappeared. This will precipitate the copper oxide from the copper nitrate, setting free the nitric acid, which, in its turn, will combine with the silver oxide. The copper will fall as a black powder mixed with any excess of silver oxide there may be. Take one or two drops of the solution in a measure, and add a drachm of water, and then add ammonia to it till the precipitate first formed is re-dissolved. If no blue colour is apparent, the substitution of the silver for the copper is complete; if not, more silver oxide must be added till the desired end is attained. Distilled water must next be added till the strength of the bath is that required. This can be tested by the argentometer. An emulsion of silver iodide *may* here appear. If it do, no matter. When the solution is filtered, the bath is fit for use, being chemically pure, neutral, and charged to a proper extent with iodide of silver.

New Baths from Old (*Second Method*).—Dilute and filter the bath as in the first method, and place in the solution strips of zinc. The silver will precipitate, as with the copper; small particles of zinc will also fall with the silver, and must be got rid of. This may be done by two methods—either by dilute hydrochloric acid, or dilute sulphuric acid (1 part of acid to 12 parts of water). The silver is collected from the solution either by filtration or decantation, and is well washed. It is then placed in a porcelain dish, and is boiled with the very dilute acid (about 1 part to 100 of acid). This dissolves the zinc, and only slightly attacks the silver. The mass is thrown on the filter, and washed well with boiling distilled water. If sulphuric acid has been used, this washing dissolves out any silver sulphate which may have been formed. The silver is dissolved up by nitric acid as in the first method. If hydrochloric acid has been used, there will remain a little silver chloride, which will be filtered out.

To Make Silver Nitrate.—Silver coins are mostly alloyed with tin or copper. In both cases the coin should be dissolved in nitric acid diluted with twice its bulk of water. If tin be present there will be an insoluble residue left of stannic oxide. The solution should be evaporated down to dryness, re-dissolved in water, filtered, and again evaporated to dryness. It will then be fit for making up a bath. If copper be present, the solution must be treated as given in the last article but one, where silver oxide is substituted for copper oxide.

Easy Tests for the Amount of Silver Nitrate in a Solution.—Take half an ounce of the solution to be tested, and precipitate the silver as chloride by adding a slight excess of hydrochloric acid or common salt. Filter the solution off, and dry the filter paper and the chloride over a water bath. The chloride can then be easily removed from the filter paper, and should be weighed. The weight multiplied by 1·18 will give the amount of silver nitrate.

Another very pretty method is as follows:—Measure with a pipette (or dropping bottle) one hundred drops of the solution to be tested; rinse the pipette, and drop from it, into the silver solution, a solution of dried salt and water (thirty-five grains to the ounce), till no more precipitate of silver chloride is seen to form. The number of drops added to the silver solution will be the number of grains of silver nitrate in the ounce of bath.

There are two methods of ascertaining when no further precipitate is formed: first, by adding a drop of potassium chromate (*not bichromate*) to the salt solution, and noting when the precipitate finally has a permanent red tinge after stirring; or the solution of salt may be placed in a stoppered bottle, and be shaken between each addition of the silver. The silver chloride agglutinates by shaking, and a fresh precipitate is seen to form at once on adding another drop of silver. When all the sodium chloride is precipitated, the solution remains milky.

Utilization of Silver Residues.—All paper or solutions in which there is silver should be saved, as it has been proved by experience that from 50 to 75 per cent. of the whole of the silver used can be recovered by rigid adherence to the careful storing of "wastes."

1. All prints should be trimmed, if practicable, before toning and fixing; in all cases these clippings should be collected. When a good basketful of them is collected, these, together with the bits of blotting-paper attached to the bottom end of sensitized paper during drying, and that used for the draining of plates, should be burnt in a stove, and the ashes collected.* These ashes will naturally occupy but a small space in comparison with the paper itself. Care should be taken that the draught from the fire is not strong enough to carry up the ashes.

2. All washings from prints, water used in the preparation of dry plates, all baths, developing solutions (after use), and old toning baths, should be placed in a tub, and common salt added. This will form silver chloride.

3. The old hyposulphite baths used in printing, and the solutions of cyanide of potassium, or sodium hyposulphite, used for fixing the negatives, should be placed in another tub. To this the potassium sulphide of commerce may be added, or else a stream of sulphuretted hydrogen passed through it till no more precipitation takes place. Silver sulphide is thus formed.

4. To No. 1 nitric acid may be added, and the ashes boiled in it till no more silver is extracted by it. The solution of silver nitrate thus produced is filtered off through white muslin, and put aside for further treatment.

5. The ashes may still contain silver chloride. This may be dissolved out by adding a solution of sodium hyposulphite, and adding the filtrate to No. 3.

6. The solution from No. 4 may next be evaporated to dryness, and crystals of silver nitrite be produced; or else common salt may be added, and the precipitate added to No. 2.

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* In large establishments the films from rejected negatives may be added.

7. No. 2, after thoroughly drying, may be reduced to metallic silver in a reducing crucible* by addition of two parts of sodium carbonate and a little borax to one of the silver chloride. These should be well mixed together, and placed in the covered crucible in a coke fire, and gradually heated. (If the operator be in possesion of one of Fletcher's gas furnaces, page 290, he can employ it economically, and with far less trouble than using the fire. It is supplied with an arrangement for holding crucibles, which is useful for the purpose.) After a time, on lifting off the cover, it will be found that the silver is reduced to a metallic state. After all conflagration has finished, the crucible should be heated to a white heat for a quarter of an hour. The molten silver should be turned out into an iron pan (previously rubbed over with plumbago to prevent the molten metal spirting), and immersed in a pail of water. The washing should be repeated till nothing but the pure silver remains.

8. The chloride may also be dissolved in sodium hyposulphite, and added to 3.

The silver hyposulphite, having been reduced to the sulphide by the addition of the potassium sulphide, is placed on a crucible and subjected to a white heat; the sulphur is driven off, and the silver remains behind.

9. A last method is that of treating the whole of the residues as hyposulphite. A sheet of zinc is placed in the tub, and the silver is precipitated in a metallic state. The supernatant liquid is syphoned off, and replenished from the other waste solutions. When the amount of silver deposited is sufficient, it is filtered out through fine calico and collected. After thorough washing it should be heated, to drive off the large amount of sulphur which is collected, and may be treated with nitric acid to form silver nitrate, or else be melted in a crucible with borax to form an ingot. If the plan be adopted of forming silver nitrate, the small amount of gold present will be left behind as a grey powder. This, after being well washed, may be treated with nitro-muriatic acid, as given below, and re-converted into trichloride. There will always be a certain amount of silver sulphate formed from the action of the nitric acid on the sulphur deposited with the silver.

Another method of reducing silver salts to the metallic state

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* The crucible should be of Stourbridge clay.

is by placing them in water slightly acidulated with sulphuric acid together with granulated zinc. The zinc is attacked, evolving hydrogen, which in its turn reduces the silver salt to the metallic state, and forming hydrochloric acid. After well washing, the silver may be dissolved up in nitric acid.

Yet another method is to take sugar of milk and a solution of crude potash, when the silver is rapidly reduced. This requires careful washing, and it is well to heat the metal to a dull red heat to get rid of any adherent and insoluble organic matter which may have been formed, before dissolving it in nitric acid.

To Procure the Silver Bromide from Waste Gelatine Emulsions, we recommend that the emulsion be boiled with one-sixth part of hydrochloric or sulphuric acid, which will destroy the gelatine and cause the bromide to precipitate. Another plan is to boil it with caustic potash and sugar of milk, when the silver will be procured in the metallic state.

The Preparation of Silver Oxide.—If to a solution of silver nitrate, a solution of potash be added, a precipitate will be formed. This is the silver oxide. The potash should be added till no further precipitation takes place. The oxide should be allowed to settle, when the supernatant fluid should be decanted off (a syphon arrangement is very convenient), and fresh distilled water added to it. This, in its turn, after the oxide has been well stirred, should be decanted off. The operation should be repeated five or six times, until a drop of the water evaporated to dryness on a clean piece of platinum foil leaves no residue. The chemical reaction is as follows:—

$$\overset{\text{Silver Nitrate}}{2AgNo_3} + \overset{\text{Potash}}{2KHO} = \overset{\text{Silver Oxide}}{Ag_2O} + \overset{\text{Potassium Nitrate}}{2K,NO_3} + \overset{\text{Water}}{H_2O}$$

The chief use of silver oxide is to neutralize a silver nitrate bath in which there is an excess of free acid, the nitric acid forming a fresh silver nitrate.

From this it is apparent that the oxide should be added till there is a slight deposit left.

The silver oxide is slightly soluble in water, hence on adding it to a bath solution it may be necessary to add a few drops of a dilute solution of nitric acid (1 part of acid to 100 parts of water).

Purifying Printing Baths.—The ordinary method of purifying a printing bath from the albuminate formed is to add a small quantity of pure kaolin, then to shake it up and filter. This method answers perfectly, but is rather wasteful.

If the bath be rendered quite neutral to litmus paper, and be placed in the sun, the organic matter is deposited together with the silver oxide, and the solution rendered pure.

If a small quantity of sodium chloride (common salt) be added, it will be found, on shaking up the silver chloride formed, that the organic matter is deposited with the chloride, and can be separated by filtration. A small quantity of saturated solution of camphor in alcohol will answer the same purpose.

The addition of a sodium carbonate answers equally well, and may be used with advantage. It is generally advisable to have a small quantity of the carbonate of silver at the bottom of the bottle, as by so doing the neutral condition of the bath is ensured, and the organic matter is continually being deposited.

Amount of Silver Nitrate to form Silver Iodide, Bromide, and Chloride, with the following:—

1 grain of	potassium iodide	requires	1·024	grains of silver nitrate.
,,	ammonium iodide	,,	1·172	,,
,,	potassium bromide	,,	1.426	,,
,,	ammonium bromide	,,	1·734	,,
,,	zinc bromide	,,	1·507	,,
,,	potassium bromide	,,	2·279	,,
,,	ammonium chloride	,,	3·177	,,
,,	sodium chloride	,,	2·906	,,

To Clean the Hands from Silver and Iron Stains.—Take hydrochloric acid and dilute it to half its strength; or, better still, chloride of lime in strong solution. Pour a quarter of an ounce of this on the hands, and rub well in till the stains disappear. Iron stains may still remain of a greenish tint. *Rinse the hands,* and apply a little dilute solution of potassium oxalate. The hands will be found free from stains. This method avoids the use of potassium cyanide or sodium hyposulphite. Chlorides of the alkalies are sometimes recommended in lieu of the hydrochloric acid; they are not so effective. The hydrochloric acid does not discolour the hands permanently. The alkaline solution in any case restores the tissues to their proper colour. After alkaline development the stains may be got rid of by oxalic acid. In all cases potassium cyanide will be effective. This should only be used with excessive caution, on account of its poisonous character. Its free use is apt to cause a species of paralysis. A mixture of 50 grains of chlorate of potash and ¼ ounce of hydrochloric acid with 1 ounce of water, is also useful.

To Take Silver and Iron Stains, &c., out of Linen.—The same procedure as above is effective; iron and silver are converted into chloride, and pyrogallic acid is decomposed by the acid. The iron washes out, and the chloride of silver is afterwards dissolved by the ammonia.

To take stains out of cloth the same method may be tried; but it is rarely completely successful by any method, as the dye will be attacked by the acid. Potassium cyanide applied with soap may be tried; but it often leaves stains caused by the mordant of the dye.

To Test for Iron in a Filter Paper.—Moisten the filter paper with a drop or two of hydrochloric acid; then add a drop of ferricyanide of potassium to the moistened part. A blue stain will show the presence of sufficient iron to be injurious to a bath solution.

Silvering Mirrors.—All the following chemicals must be absolutely pure to ensure success.

The following is the formula given by Martin:—

No. 1.—	Silver nitrate	17·5 grains
	Water (distilled)	1 ounces
No. 2.—	Ammonia nitrate...	26·25 grains
	Water (distilled)	1 ounce
No. 3.—	Caust. pot. free from Cl and CO...	44 grains
	Water (distilled)	1 ounce

No. 4.—Dissolve 440 grains of sugar in 10 ounces of distilled water, 53 grains of tartaric acid, and boil for ten minutes. Next add 2 ounces of alcohol, and add sufficient water to make up to 20 ounces if the silvering is to be done in winter, or to more if it is to be done in summer.

The effect of tartaric acid on the sugar is to produce inverted sugar, which reduces the silver from the mixed solutions.

In our own practice we use about 31 grains of ammonium nitrate, instead of 26·25 grains, the crystals being dried beforehand.

The plate is cleaned with concentrated nitric acid, by the aid of cotton-wool perfectly free from all extraneous matter (see page 29). It is then washed in distilled water, and dried. Equal parts of No. 3 and alcohol are next applied, and whilst still wet the plate is placed in distilled water, and all the alkali rubbed off by a badger-hair brush. The plate is finally placed face downwards in distilled water, resting on a couple of *clean* strips of glass.

To prepare the silvering solution, equal parts of Nos. 1 and 2 are mixed in one measure, and the same quantities of 3 and 4 in another. The mixture in the second measure is poured into the first measure, and after thoroughly stirring the whole is transferred into a dish. The quantity should be so arranged that the solution just covers the bottom surface of the plate to be silvered when resting upon wedges (wooden ones covered with india-rubber solution will answer) about a quarter of an inch in height. The solution being poured in, the plate is placed on the silver. If the mixture becomes blackly turbid at once, it is probable there is not enough of No. 2 present; whilst if it remain clear for two or three minutes, there is probably an excess. When the solution turns inky black the silvering commences, and the dish should then be rocked slightly for about five to ten minutes, when, if correctly made up, the solution should become clear, and flakes of silver float up to the top. The glass will now be covered with a coating of silver, and it should appear perfectly bright if the chemicals are *pure*, and if the plate has not been left too long in the solution. The deposit should be very nearly opaque; any light passing through should be of a deep indigo colour. There is often a little bloom on the surface, which, when the surface is dried, can be removed by a tuft of cotton-wool. A surface which is slightly matt can be polished by a pad of *fine* chamois leather and a little jeweller's rouge. The pad should be warmed, and the polishing done with a light hand. A green tint in the deposit indicates defective cleaning of the plate; whilst a purple tint indicates something wrong in the solutions.

To Make Gold Tri-Chloride [$Au\ Cl_3$].—Place a half-sovereign (which may contain silver as well as copper) in a convenient vessel; pour on it half a drachm of nitric acid, and mix with it two-and-a-half drachms of hydrochloric acid; digest at a gentle heat, but do not boil, or probably the chlorine will be driven off. At the expiration of a few hours add a similar quantity of the acids. Probably this will be sufficient to dissolve all the gold. If not, add acid the third time; all will have been dissolved by this addition, excepting, perhaps, a trace of silver which will have been deposited by the excess of hydrochloric acid as silver chloride. If a precipitate should have been formed, filter it out, and wash the filter paper well with distilled water. Take a filtered solution of ferrous sulphate (eight parts water to one of iron) acidulated with a few drops of hydrochloric acid, and add the gold solution to it; the iron will cause the gold alone to deposit as metallic gold, leaving the copper in solution. By adding the gold solution to the iron the precipitate is not so fine as if added *vice versa.* Let the gold settle, and pour off the liquid; add water, and drain again, and so on till no acid is left, testing the washings by litmus paper. Take the metallic gold which has been precipitated, re-dissolve in the acids as before, evaporate to dryness on a water bath that is at a heat not exceeding 212° F. The resulting substance is the gold trichloride. To be kept in crystals, this should be placed in glass tubes hermetically sealed. For non-commercial purposes it is convenient to dissolve it in water (one drachm to a grain of gold). Ten grains of gold dissolved yield 15·4 grains of salt. Hence, if ten grains have been dissolved, 15·4 drachms of water must be added to give the above strength.

Preparation of Platinum Tetra-Chloride. [$Pt\ Cl_4$].—Take any old scraps of platinum foil or wire, and having cleaned them with boiling nitric acid, place them in a porcelain dish containing aqua regia (four parts of hydrochloric to one of nitric acid). By the aid of heat this will cause a solution of platinum tetrachloride to be formed. The solution is evaporated nearly to dryness, or until it becomes viscous. It is then re-dissolved in water, and evaporated to the same state once more. For photographic purposes, this may be re-dissolved again in distilled water of the strength of one grain of the tetra-chloride to one drachm of water. It should be remembered that every 10 grains of platinum yield 17·2 grains of the tetra-chloride; hence, with every 10 grains of platinum dissoloved, 17·2 drachms of water must be added to make it of the above strength.

Testing for the Amount of Water in Alcohol.—Take a small quantity of chloroform and pour it into a graduated test-tube. Add to it a given quantity of the alcohol to be tested. Shake up both well together. On settling, the water will have combined with the chloroform, and the difference in volume may be read off the test-tube.

Another method is to add an *excess* of dry carbonate of potash to a given quantity, and then to read off the amount of fluid left, calculating it as of ·814 sp. gr. This obtains on account of the insolubility of the carbonate in alcohol and its affinity for water.

Testing for Methylated Alcohol.—If a small quantity of caustic potash be added to alcohol suspected of being methylated, the presence of the impurity will be indicated by a brownish tint being given to the liquid.

Soda Developer.—The following is a formula for a soda developer to be used with gelatine plates. It is taken from an article by Mr. Genlain, in the *British Journal of Photography*:—

	Winter Formula.	Summer Formula.
Ordinary washing soda...	5 ounces	5 ounces
Potassium bromide	15 grains	40 grains
Water	50 ounces	50 ounces

To each ounce of the above use one grain of pyrogallic acid for developing.

To Decolourize Collodion.—Add to the collodion small sttrips of metallic cadmium, zinc, or silver, and shake well. With the two first metals the iodide formed will be dissolved by the collodion solvents. With the last the iodide will remain at the bottom of the bottle, except that part dissolved by the other soluble iodides.

To Remove the Varnish from a Negative.—Varnish may be removed from a negative by warming it gently, and applying spirits of wine to its surface. The spirit must be poured off, the plate re-heated, and a fresh quantity applied as before. This operation must be continued till the varnish appears to be totally dissolved from the surface of the negative. Alcohol vapour made by heating spirits of wine over a spirit lamp in a test tube is very rapid in its solvent action. A final rinse of spirits should, however, always be given. A moderately strong solution of caustic potash will also remove most varnishes, and is recommended as simpler than the first method.

To Bend Glass Tubing.—Ordinary glass tubing can be bent by simply placing the part where the curve is required in the flame of a spirit lamp, or in an ordinary gas flame. The tube should be held by the two hands, and turned round between the fingers, so that the whole of the surface to be acted upon gets equally heated. When the glass feels softened, a gentle pressure by the hands will give the necessary bend. If the heated surface be small, the tubing will not remain circular in section at the bend, but will be flattened.

To Make a Syphon.—Bend a piece of tubing so as to form two legs nearly parallel; pierce a cork with two holes, and in one fit tightly one leg of the bent tubing, and in the other fit in a piece of straight tubing. To use the syphon, if the cork fit the bottle, press it tightly into the neck; or if it be larger, press it firmly on to its lip. See that the straight tube is above the level of the liquid, whilst the leg is well in it. Blow down the former till the liquid rises past the bend of the latter, when a constant flow will result, till the level of the inner or outer leg (according to which is the higher of the two) is reached.

Convenient Dropping Bottles.—A convenient dropping-bottle may be formed with any ordinary four or six-ounce bottle by cutting a slot in the cork from end to end, and fixing it in the bottle in the ordinary manner. If this and an ordinary cork be attached to the neck of the bottle by twine, the two may be interchanged as required.

Ground Glass and its Substitutes.—When the ground glass of the camera has beeen broken, circumstances sometimes prevent it being replaced by a purchased article. The following method will give a substitute for it:—

Take a piece of glass of the size to be ground. Lay it flat on a board or table, sprinkle the finest emery over the surface, and moisten it. With another small piece of glass grind it smoothly and evenly till a uniform grain is apparent over the whole surface. The finer the emery the finer will be the resulting grain. A substitute for ground glass can be produced by sensitizing a plate as usual, exposing and developing till there is a fair deposit on the film (if the developer be acidified with nitric acid in lieu of acetic acid, the silver will be deposited in a white form); use the silver as the ground surface of the glass. White wax dissolved in ether, and flowed over the plate as in mounting transparencies (see page 187), gives the finest surface possible on which to focus.

To Find the Equivalent Focus of a Lens, and its Distance from an Object for Enlarging, &c.—The equivalent focus of a lens is a term applied to a compound lens. It is the focus of parallel rays entering the lens. It is termed "equivalent" from being compared with a single lens that would produce the same sized image at the same distance from the object.

Measure a distance of (say) one hundred and fifty feet away from some fixed point, and place a rod at one extremity. From this point measure a line exactly at right angles to the first, of some forty feet in length, and place another rod at its other end. Now place the front of the camera exactly over the starting point of the first line, and level it, the lens being in the direction of the first line. Having marked a central vertical line on the ground glass with a pencil, focus the first rod accurately, so as to fall on the pencil line on the ground glass. Take a picture of the two rods in the ordinary way, and measure back as accurately as practicable, the distance of the centre of the ground glass from the starting point, and also the distance apart of the two images of the rods (at their base) upon the negative.

Fig. 54.

Suppose the first measured line, AB, to be 149 feet; BD, the second line, to be 35 feet; AC to be 1 foot; and EC, the distance apart of the two images, to be 3 inches, F being the point where DE cuts CB.

Then BD+CE : CB : : CE : CF, which is the equivalent for focal distance.

Here, CB=150 ft. BD+CE=35·25 ft. CE=·25 ft.

$$\therefore CF=\frac{150+{\cdot}25}{35{\cdot}25}=1{\cdot}063 \text{ ft.}$$

This gives the equivalent focal distance, which is the distance of the ground glass from the optical centre. Having taken the thickness of the ground glass previously, the distance may be set off from its smooth side on to the brass work of the lens by a pair of callipers. This point (the optical centre) having once been obtained, its position should be marked on the brass work, and from it all measurements should be calculated. This method is *very nearly* methematically accurate. Were the distance taken of shorter length than those given, an appreciable error might be found. At the distance given the rays of light entering the lens from the rod are virtually parallel, and thus fulfil the necessary conditions. It must also be remarked that the distance AB being so great in comparison with AC as that any slight error in the back measurement will affect the result by an inappreciable quantity, CE should be measured most accurately from the negative. The mean of a series of trials should be taken.

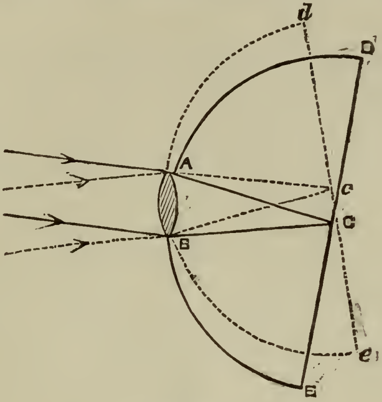

Fig. 55.

Having obtained the equivalent focal distance of the lens, the respective distance of the object and ground glass from the optical centre can be obtained by the following formulæ :—

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u}$$

which is easily reduced to

$$v = \frac{f(n+1)}{n} \text{ and } u = nv$$

where v is the distance of the focussing screen, u that of object from the optical centre, and f the equivalent focus of the lens, n being the linear reduction, or enlargement.

On the following page is a table of enlargement or reduction for lenses with certain equivalent focal distances.

TABLE OF ENLARGEMENT OR REDUCTION.

Equivalent Focus of Lens.	Reduction.	Enlargement or Reduction. 1	2	3	4	5	6	Enlargement.	Remarks.
6″	*u*	12	18	24	30	36	42	*v*	*v*=distance of image on ground glass, and *u*=distance of the object from the centre.
	v	12	9	8	7½	7⅕	7	*u*	
6½	*u*	13	19½	26	32½	39	45½	*v*	
	v	13	9¾	8⅔	8⅛	7⅘	$7\frac{7}{12}$	*u*	
7	*u*	14	21	28	35	42	49	*v*	
	v	14	10½	9⅓	8¾	8⅖	8⅙	*u*	
7½	*u*	15	22½	30	37½	45	52½	*v*	
	v	15	11¼	10	9⅜	9	8¾	*u*	
8	*u*	16	24	32	40	48	56	*v*	
	v	16	12	10⅔	10	9⅗	9⅙	*u*	
8½	*u*	17	25½	34	42½	51	59½	*v*	
	v	17	12¾	11⅓	10⅝	10⅕	$9\frac{7}{12}$	*u*	
9	*u*	18	27	36	45	54	63	*v*	
	v	18	13½	12	11¼	10⅞	10½	*u*	
9½	*u*	19	28½	38	47½	57	66½	*v*	
	v	19	14¼	12⅔	11⅞	11⅖	$11\frac{1}{12}$	*u*	
10	*u*	20	30	40	50	60	70	*v*	
	v	20	15	13⅓	12½	12	11⅔	*u*	
10½	*u*	21	31½	42	52½	63	73½	*v*	
	v	21	15⅔	14	13⅛	12⅗	12¾	*u*	
11	*u*	22	33	44	55	66	77	*v*	
	v	22	16½	14⅔	13¾	13⅓	12⅚	*u*	
11½	*u*	23	34½	46	57½	69	80½	*v*	
	v	23	17¼	15⅓	14⅜	13⅘	$13\frac{5}{12}$	*u*	
12	*u*	24	36	48	60	72	84	*v*	
	v	24	18	16	15	14⅖	14	*u*	

Applying this table to an example :—Suppose the equivalent focal distance of the lens to be 9½″, and that it is desired to find the distance at which the ground glass and the object are to be placed, to give an enlargement of four times linear (*i.e.*, sixteen times in area). In the first column find 9½, and trace it horizontally till it reaches the column headed 4. Then 47½″ will be the distance of the screen from the optical centre of the lens; and 11⅞ the distance of the object from the same point.

Where any lens is used for copying, it is useful to find out the *exact* equivalent focus, and to make a table similar to this for it. By so doing, if a scale be marked on the baseboard of the camera, the plan or object to be enlarged or reduced may be placed in proper position at once, as may also the ground glass.

To Calculate Exposures with Lenses of Different Focal Lengths, and Different Sizes of Diaphragms (Stops).—Let AB be the lens having a focal length (AC or BC), describe a circle with distance AC, and centre C. It is manifest that the parallel rays proceeding from a distant point to form an image of the point at C only, a small part of the theoretical possible rays are collected, viz., those falling on a circle having a diameter AB (fig. 55). The theoretically possible rays would be collected on the surface of a hemisphere DABE. The proportion of rays collected to those theoretically possible is therefore—

$$\frac{\pi(\mathrm{AB})^2}{2\pi(\mathrm{BC})^2} \text{ or } \frac{(\mathrm{AB})^2}{2(\mathrm{BC})^2}$$

which shows that the illumination varies directly as the square of the aperture of the lens, and inversely as the square of the focal length, or as $(\frac{f}{a})^2$, calling f the focal length, and a the aperture of the lens. If, then, we wish to compare two lenses with different apertures and focal lengths together, all that is requisite is to use the following formula :—

$$\frac{\left(\frac{f_1}{a_1}\right)^2}{\left(\frac{f}{a}\right)^2} \times s = x$$

(the exposure required with the second lens) where f_1 and a_1 are the focal length and aperture respectively of the second lens.

As an example, suppose it is known that a lens of twelve-inch focal length, and one-quarter of an inch opening, requires an exposure of ten seconds, what exposure must be given to the same picture with a lens of ten-inch focus, and one-eighth of an inch aperture? The above formula is—

$$\frac{\left(\frac{10}{\frac{1}{8}}\right)^2}{\left(\frac{12}{\frac{1}{4}}\right)^2}\times 10 = x = 28 \text{ seconds nearly.}$$

It will also be seen that, with the same lens, the exposure necessary to be given varies inversely as the square of the diameter of the stop; thus, suppose with a lens having a stop of half-an-inch diameter an exposure of ten seconds is required; it would require for a stop having a quarter-of-an-inch diameter four times the exposure—or forty seconds. In general, if an s be in exposure with a stop of diameter a, with a stop of diameter b, the exposure will be

$$s\frac{a^2}{b_2}$$

Comparative Value of Numbers on Warnerke's "Standard Sensitometer."—The following table was compiled by Mr. Cadett for issue with his gelatine plates:—

	Number of times more sensitive than										
	25	24	23	22	21	20	19	18	17	16	15
25	1	$1\frac{1}{3}$	$1\frac{3}{4}$	$2\frac{1}{3}$	3	4	5	7	9	12	16
24		1	$1\frac{1}{3}$	$1\frac{3}{4}$	$2\frac{1}{3}$	3	4	5	7	9	12
23			1	$1\frac{1}{3}$	$1\frac{3}{4}$	$2\frac{1}{3}$	3	4	5	7	9
22				1	$1\frac{1}{3}$	$1\frac{3}{4}$	$2\frac{1}{3}$	3	4	5	7
21					1	$1\frac{1}{3}$	$1\frac{3}{4}$	$2\frac{1}{3}$	3	4	5
20						1	$1\frac{1}{3}$	$1\frac{3}{4}$	$2\frac{1}{3}$	3	4
19							1	$2\frac{1}{3}$	$1\frac{3}{4}$	$2\frac{1}{3}$	3
18								1	$1\frac{1}{3}$	$1\frac{3}{4}$	$2\frac{1}{3}$
17									1	$1\frac{1}{3}$	$1\frac{3}{4}$
16										1	$1\frac{1}{3}$
15											1

The numbers down to 15 only are given, this being more than sufficient for comparison of most plates. Supposing it is desired to compare the rapidity of two plates showing different numbers, look for the higher number in the column on the left side of the table, and the lower one in the top horizontal row of numbers, then run the eye along the line of the number in the left-hand column until you come to the figure under the lower number; the figure will then show the number of times more sensitive is the plate showing the higher number than the plate showing the lower number. For instance, a plate showing 21 is four times more sensitive than one showing 16; one showing 20 is three times more sensitive than one showing 16, and so on.

How to Calculate the Amount necessary to form a Compound formed by Double Decomposition.—How many grains of silver nitrate must be added to twenty grains of zinc bromide to exactly convert the bromine in the latter to silver bromide?

From the table of combining weights, it will be seen the combining weight of Zn is 65·2, of Br 80, of Ag 108, of N 14, of O is 16.

Since Zn combines with two equivalents of Br, the formula for zinc bromide is $Zn\,Br_2$, hence its combining weight is $65{\cdot}2 \times 2 + 80 = 225{\cdot}2$. The formula for silver nitrate is $AgNO_3$, hence its combining weight is $108 + 14 + 3 \times 16 = 170$.

Now, as in each molecule of zinc bromide there are two atoms of bromine, and in each molecule of nitrate of silver one atom of silver, in order to form silver bromide, which is $AgBr$ (since Ag combines with one atom of Br), two molecules of silver nitrate must be brought in contact with one molecule of zinc bromide. We can, therefore, form a simple rule-of-three sum—

Combining weight of Zinc Bromide		Twice the combining weight of Silver Nitrate		Grains of Zinc Bromide		Grains of Silver Nitrate
225·5	:	2 × 170	::	20	:	x

or $x = 20 \times 170 \times 2\ 225{\cdot}5 = 30{\cdot}2$ grains of silver nitrate.

How many grains of silver nitrate are required to be added to fifteen grains of sodium chloride, in order that all the chlorine in the latter may be in combination with the silver?

As before, the combining weight of silver nitrate is 170, of sodium chloride 58·5, for since sodium is a monad, its formula is $NaCl$. Since there is only one atom of chlorine in each molecule of sodium chloride, we do not double the combining weight of silver nitrate, and we get—

Combining weight of Sodium Chloride		Combining weight of Silver Nitrate		Grains of Sodium Chloride		Grains of Silver Nitrate
58·5	:	170	: :	15	:	x

or $x = 15 \times 170\ 58{\cdot}5 = 45{\cdot}6$ nearly.

How many grains of silver nitrate and potassium iodide must be used to form thirty grains of silver iodide?

The combining weights of silver iodide, potassium iodide, and silver nitrate are arrived at as before, and are 235, 165·1, and 170, respectively. We proceed exactly as before. We will find the amount of potassium iodide—

Combining weight of Silver Iodide		Combining weight of Potassium Iodide		Grains of Silver Iodide		Grains of Potassium Iodide
235	:	166·1	: :	30	:	x

or $x = 21{\cdot}2$ grains of potassium iodide.

Similarly, by substituting 107 for the 166·1 in the above, we should find that the amount of silver nitrate to be used in forming thirty grains of silver iodide was 21·7 grains.

An Intensifier for Gelatine Plates.—Make up the following:—

I.—	Bichloride of mercury	½ ounce
	Potassium bromide	½ ,,
	Water	20 ounces
II.—	Potassium cyanide	¼ ounce
	Water	20 ounces

To No. II. add a solution of silver nitrate (100 grains to the ounce of water) till a precipitate is formed, which does not re-dissolve. These should be mixed twenty-four hours before use. To intensify the negative, place the plate, after fixing and washing, in the alum bath (page 148) for a quarter of an hour, and then immerse it in No. I. till it bleaches and becomes like a positive. Wash well, and then place it in No. II. till it becomes black. Wash again thoroughly, and allow the negative to dry. Misty shadows show want of washing at some stage.

TABLE OF THE SYMBOLS AND COMBINING WEIGHTS OF THE MOST COMMON ELEMENTS.

Name:	Symbol.	Comb. Weight	Name.	Symbol.	Comb. Weight.
Aluminium	Al	... 27·4	Lead	Pb	... 207
Antimony	Sb	... 122·0	Lithium	Li	... 7
Arsenic	As	... 75	Magnesium	Mg	... 24
Barium	Ba	... 137	Manganese	Mn	... 55
Bismuth	Bi	... 210	Mercury	Hg	... 200
Boron	B	... 11	Nickel	Ni	... 58·7
Bromine	Br	... 80	Nitrogen	N	... 14
Cadmium	Cd	... 112	Oxygen	O	... 16
Calcium	Ca	... 40	Palladium	Pa	... 106·6
Carbon	C	... 12	Phosphorus	P	... 31
Chlorine	Cl	... 35·5	Platinum	Pt	... 98·7
Chromium	Cr	... 52·2	Potassium	K	... 39·1
Cobalt	Co	... 59	Silicon	Si	... 28
Copper	Cu	... 63·5	Silver	Ag	... 108
Fluorine	F	... 19	Sodium	Na	... 23
Gold	Au	... 197	Strontium	Sr	... 87·5
Hydrogen	H	... 1	Sulphur	S	... 32
Iodine	I	... 127	Tin	Sn	... 118
Iridium	Ir	... 198	Uranium	U	... 120
Iron	Fe	... 56	Zinc	Zn	... 65·2

Weights and Measures.

1 Sovereign weighs	123·274 grains
1 Shilling ,, ...	87·273 ,,
48 Pence ,, ...	1 lb. avoirdupois
Half-penny and three-penny piece weigh	¼ ounce
Florin and sixpence	½ ,,
Three pennies	1 ,,
4 half-crowns and 1 shilling	2 ounces
4 Florins, 4 half-crowns, 2 pennies ...	4 ,,

1 Half-penny = 1 inch in diameter

AVOIRDUPOIS WEIGHT.

$27\frac{11}{32}$ Grains	1 drachm	(= $27\frac{11}{32}$ grs.)
16 Drachms	1 ounce	(= 437½ ,,)
16 Ounces	1 pound	(= 7000 ,,)

TROY WEIGHT.

24 grains	1 pennyweight	(= 24 grains)
20 pennyweights ...	1 ounce	(= 480 ,,
12 ounces...	1 pound	(= 5760 ,,

OLD APOTHECARIES' WEIGHT (superseded in 1864).

20 Grains	1 scruple	(= 20 grains)
3 Scruples	1 drachm	(= 60 ,,)
8 Drachms	1 ounce	(= 480 ,,)
12 Ounces	1 pound	(= 5760 ,,)

The New Apothecaries' Weight is the same as Avoirdupois.

LIQUID MEASURE.

60 Minims	1 drachm
8 Drachms...	1 ounce=1·73 cub. inches nearly
20 Ounces	1 pint=34·66 ,, ,,
8 Pints	1 gallon=277·25 ,, ,,

The Imp. Gallon is exactly 10 lbs. Avoir. of pure water; the pint, 1¼ lbs.

FLUID MEASURE.

1 Minim	=	1 drop	2 Drs.	=	1 dessert spoonful
1 Drachm	=	1 teaspoonful	4 ,,	=	1 table ,,

FRENCH MEASURES.

1 Gramme ...	15·432 grains
Kilogramme ...	1000 grammes (=2·2 lbs. Avoir. nearly)
1 Litre	35·216 ounces (fluid)
1 Cubic Centimetre (c.c.) ...	17 minims nearly
50 Cubic Centimetres ...	1 ounce 6 drachms 5 minims
1 Metre...	39·37 inches

CHEMICAL COMPOUNDS TO WHICH REFERENCE IS MADE IN THE BOOK.

New Nomenclature.	Symbols.	Common Names.
Ammonium bromide	$NH_4\ Br$	Bromide of ammonium
,, chloride	$NH_4\ Cl$	Chloride of ammonium
,, iodide	$NH_4\ I$	Iodide of ammonium
Barium nitrate	$Ba(NO_3)_2$	Nitrate of baryta
,, sulphate	$Ba\ SO_4$	Sulphate of baryta
Cadmium bromide	$Cd\ Br_2$	Bromide of cadmium
,, chloride	$Cd\ Cl_2$	Chloride of cadmium
,, iodide	$Cd\ I_2$	Iodide of cadmium
Calcium chloride	$Ca\ Cl_2$	Chloride of calcium
Cupric chloride	$Cu\ Cl_2$	Chloride of copper
Ferric nitrate	$Fe\ (NO_3)_3$	Pernitrate of iron
,, sulphate	$Fe_2\ (SO_4)_3$	Persulphate of iron
Ferrous nitrate	$Fe\ (NO_3)_2$	Proto-nitrate of iron
,, sulphate	$Fe\ SO_4$	Protosulphate of iron
Gold trichloride	$Au\ Cl_3$	Terchloride of gold
Hydrogen sulphide	$H_2\ S$	Sulphuretted hydrogen
Iridium chloride	$Ir\ Cl_3$	Chloride of iridium
Mercuric chloride	$Hg\ Cl_2$	Bichloride of mercury (corrosive sublimate)
Mercurous chloride	$Hg\ Cl$	Calomel
Platinum tetrachloride	$Pt\ Cl_4$	Dichloride of platinum
Potassium bromide	$K\ Br$	Bromide of potassium
,, chloride	$K\ Cl$	Chloride of potassium
,, iodide	$K\ I$	Iodide of potassium
,, dichromate	$K_2\ Cr_2\ O_7$	Bichromate of potash
,, permanganate	$KMnO_4$	Permanganate of potash
Silver bromide	$Ag\ Br$	Bromide of silver
,, chloride	$Ag\ Cl$	Chloride of silver
,, iodide	$Ag\ I$	Iodide of silver
,, oxide	$Ag_2\ O$	Oxide of silver
,, nitrate	$Ag\ NO_3$	Nitrate of silver
,, sulphate	$Ag_2\ SO_4$	Sulphate of silver
Sodium chloride	$Na\ Cl$	Common salt
Sulphuric acid	$H_2\ SO_4$	Sulphuric acid
Zinc iodide	$Zn\ I_2$	Iodide of zinc
,, bromide	$Zn\ Br_2$	Bromide of zinc
,, chloride	$Zn\ Cl_2$	Chloride of zinc

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No. 3	for Portraits	6½× 4¾	£17	10	0
,, 3A	,,	8½× 6½	26	15	0
,, 4	,,	10 × 8	38	0	0
,, 5	,,	18 ×16	42	10	0
,, 6	,,	22 ×18	54	0	0

RAPID "CABINET."

No. 1	for Cabinets,	14ft. distance	13	0	0
,, 2	,,	18ft. ,,	17	10	0
,, 3	,,	20ft. ,,	19	10	0

EXTRA RAPID C.D.V.

Invaluable for Photographing Children.

No. 2A,	4½in. focus,	dia. 2½in.	13	10	0
,, 3A,	6 in. ,,	dia. 3¼in.	25	0	0

QUICK-ACTING C.D.V.

No. 1	for Cards,	14ft. distance	5	15	0
,, 2	,,	16ft. ,,	6	10	0
,, 3	,,	19ft. ,,	11	10	0

UNIVERSAL.

For Portraits, Groups, &c.

No.	View Size.	Group Size.	Back Focus.	Price.		
1	8½×6½	7¼×4½	8½in.	7	10	0
2	10×8	8½×6½	10¾in.	9	0	0
3	12×10	10×8	13½in.	12	10	0
4	15×12	12×10	16½in.	16	10	0
5	18×16	15×12	20 in.	25	0	0
6	22×18	18×16	24 in.	45	0	0
7	25×21	22×18	30 in.	55	0	0

VIEW LENSES.

SYMMETRICAL.*

For Landscapes and Architecture.

No. 1	3 ×3	4 ×3	5 ×4	3in.	£3	0
,, 2	4 ×3	5 ×4	7¼×4½	4in.	3	5
,, 3	5 ×4	7¼×4½	8 ×5	5in.	3	10
,, 4	7¼×4½	8 ×5	8½×6½	6in.	4	0
,, 5	8 ×5	8½×6½	9 ×7	7in.	5	0
,, 6	8½×6½	9 ×7	10×8	8in.	6	0
,, 7	9 ×7	10×8	12×10	9in.	7	0
,, 8	10×8	12×10	13×11	10in.	8	0
,, 9	12×10	13×11	15×12	12in.	9	0
,, 10	13×11	15×12	18×16	15in.	10	0
,, 11	15×12	18×16	22×18	18in.	12	0
,, 12	18×16	22×20	25×21	21in.	15	0

RAPID SYMMETRICALS.*

For Groups, Views, Interiors, and Copying. The most useful Lens for all Out-door Photography.

Size of View.	Size of Group.	Equivalent. Focus.	Price.		
4 × 3	Stereo.	4¼in.	£4	0	0
5 × 4	4 × 3	6 in.	4	5	0
6 × 5	5 × 4	7½in.	5	5	0
8 × 5	7¼× 4½	9 in.	5	15	0
8½× 6½	8 × 5	10½in.	6	10	0
9 × 7	8½× 6½	12in.	7	10	0
10 × 8	8½× 6½	14in.	8	10	0
12 ×10	10 × 8	16in.	10	10	0
13 ×11	11 × 9	18in.	11	10	0
15 ×12	13 ×11	20in.	14	10	0
18 ×16	15 ×12	24in.	18	10	0
22 ×18	18 ×16	30in.	25	0	0
25 ×22	22 ×18	34in.	30	0	0

* Furnished with Diaphragms on the Standard System recommended by the Photographic Society of Great Britain.

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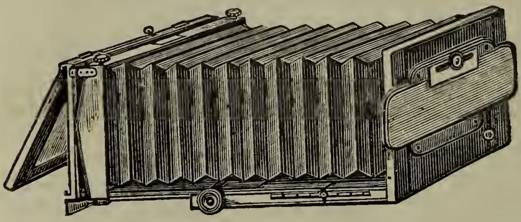
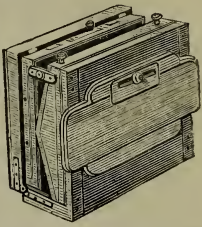
G. HARE'S Improved Portable Bellows Camera

INTRODUCED 1878.





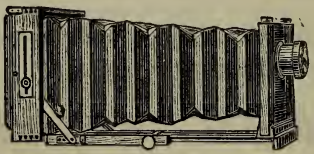
This Camera is exceedingly simple in design, can be easily set up and taken down, is perfectly rigid and steady when in use. It has double swinging back. After the Camera has been drawn out to its fullest extent and clamped, it can then, by means of screw or rack adjustment, be extended two-thirds of the length of the base-board more, thus giving a range of focus for a 7½ by 5 Camera from 2¾ inches to 17 inches. The dark slide can be made the size of plate for the Square Camera; this, fitting on a frame, can be placed either in a vertical or horizontal position.

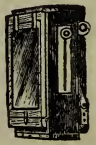
PRICES, with one Single Back, two Inner Frames, and Focussing Screen.

For Plates.	*Horizontal and Vertical.*	*Square.*	*Brass Binding.*
7¼ by 4½	£6 5 0	£7 0 0	£1 0 0
7½ by 5	6 10 0	7 5 0	1 0 0
8½ by 6½	7 15 0	8 10 0	1 0 0
10 by 8	9 0 0	10 0 0	1 5 0
12 by 10	10 5 0	11 15 0	1 10 0
15 by 12	12 15 0	14 15 0	2 0 0

G. HARE'S NEW PATENT CAMERA.

INTRODUCED JUNE, 1882.





This Camera combines all the advantages of the Kinnear form, without any of its disadvantages. It is extremely light and portable, yet very firm and rigid; it has no loose parts, and may be set up and taken down more readily than any camera yet devised. The 6½ by 4¾ size will focus from 3 inches to 14 inches, and if made square with reversible holder, from 3 inches to 17 inches; the weight of the latter is 3 lbs. 12 ozs.

Illustrated Price List on Application at the Factory.

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The PLATINOTYPE PROCESS is peculiarly adapted to the requirements of Amateurs, both on account of the simplicity, cleanliness, and rapidity of the operations, and because of the refined and artistic effects which may be produced.

Every Amateur who has gone through the drudgery of Silver Printing, cannot fail to be delighted with the emancipation he achieves when he quits that method for the delightful and permanent Platinotype Process.

There cannot be a shadow of doubt that Platinotype has a very important future before it; and all Photographers should lose no time in making themselves acquainted with the method by which pictures, greatly raising photography in the estimation of artists and of men of taste, may be obtained.

Looked at from another point of view, Platinotype gives another "string to the bow" to those photographers who rightly are alive to the advantages of securing *really solid* novelties for introduction to their *clientéle.*

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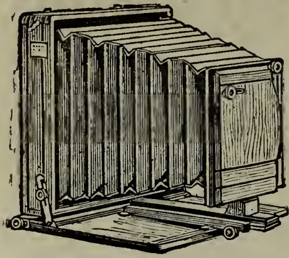
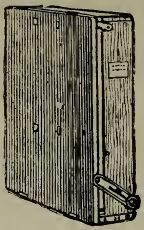
THE PLATINOTYPE COMPANY,
29, Southampton Row, High Holborn,
LONDON, W.C.

ROUCH'S NEW PATENT CAMERA.





(Prize Medal awarded at the Bristol International Photographic Exhibition, 1881.)

This Camera is the lightest and most portable in the market for landscape and general purposes, these qualities being secured without any loss of strength or rigidity, while the workmanship is of the highest class. The constantly increasing demand for the New Patent Camera sufficiently proves that these features are appreciated, and those who have had the instrument in use for a considerable period acknowledge it to be undoubtedly the most convenient and efficient. Hundreds of Testimonials have been received. The great saving in weight is specially noticeable when using plates of large size.

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Improved Folding-Tail Camera, for Plates 4¼ by 3¼, and 3 Double Backs, with Rack Adjustment, Folding Tripod Stand, Ross' View and Group Lens, a Chemical Laboratory fitted, Non-actinic Lantern, Sling Case to hold Camera, Backs, Lens, &c.; Light-tight Box, Ebonite and Porcelain Trays, Printing-Frames, Sensitized Paper, Printing Materials, 1 doz. Dry Plates, and every other requisite, all of the finest quality of workmanship	£11	5	0
The above Set for pictures 5 by 4	13	5	0
Complete Set as above, for plates 7½ by 5, *with New Patent Camera, double Swing Back,* and Ross' Portable Symmetrical Lens	17	10	0
Ditto ditto for plates 8½ by 6½	21	10	0

ROUCH'S ORIGINAL MODEL TENT, prepared for changing or developing WET or DRY Plates. Is the most PERFECT Portable Dark Room. 8½ by 6½ size, price £6 10s.

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TOURISTS' DRY PLATE CAMERAS.

Fine quality (light and portable), fitted with 3 Double Backs, and Rack Adjustment, at following prices:—4¼ by 3¼, £4 5s.; 5 by 4, £4 15s.; 6½ by 4¾, £5 10s.; 7½ by 5, £5 18s. NEW SWING BACK, from 10s. to 12s. 6d. extra.

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FINEST QUALITY.—5 by 4, £2 2s.; 7½ by 5, £3 3s.; 8½ by 6½, £4 4s.; 10 by 8, £5 15s. 6d.; 12 by 10 to 15 by 12, £7. SPECIMEN PICTURES ON VIEW, or SENT FOR TWO STAMPS.

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	10 and 30 times. s.	d.	60 times. s.	d.		10 and 30 times. s.	d.	60 times. s.	d.
4¼×3¼	1	6	2	0	7½×5	5	0	6	0
5×4	2	3	3	0	8½×6½	6	0	8	0
6¾×3¼	3	2	3	6	9×7	7	6	9	0
6½×4¼	3	4	4	0	10×8	10	6	12	6
6½×4¾	3	6	4	6	11×9	13	0	15	6
7¼×4½	3	9	4	9	12×10	15	0	18	0
7×5	4	0	5	0	15×12	26	6	30	0

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Size of Hood of Lens	1½ in.	2 in.	2½ in.	3 in.	3½ in.	4 in.
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